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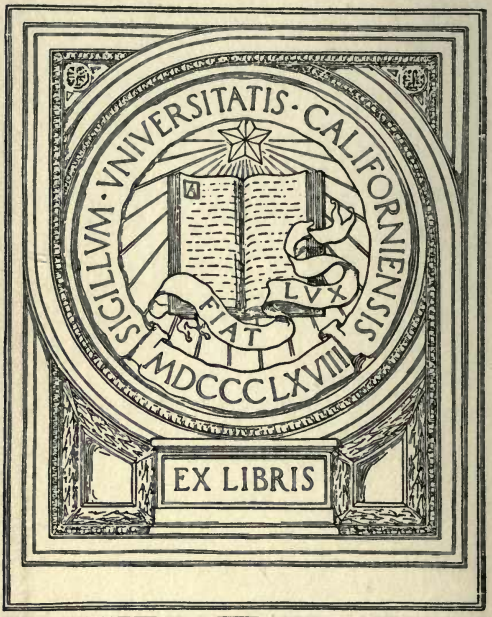

Gift of:
G. M. Goddard

16 1911

1909

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NATIONAL ELECTRICAL CODE"

INSTALLATION RULES

(Except Marine Work)

OF THE

tional Board of Fire Underwriters

FOR

ELECTRIC WIRING

AND

APPARATUS

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As Recommended by the

DERWRITERS' NATIONAL ELECTRIC ASSOCIATION

—

SUPPLEMENT.

For satisfactory work only approved fittings should be used. The Supplement to the National Electrical Code, containing a list of approved electrical fittings, is designed to aid wiremen by showing them in advance just what will be approved by the Underwriters. Fittings not listed should not be used without special approval, which will be freely given on application, if the device is found to be reliable.

The Supplement will be revised semi-annually.

1909

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As Recommended by the

UNDERWRITERS' NATIONAL ELECTRIC ASSOCIATION

EDITION OF 1909

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GIFT
C. M. Goddard,

The National Electrical Code was originally drawn in 1897 as the result of the united efforts of the various Insurance, Electrical, Architectural and allied interests which through the National Conference on Standard Electrical Rules, composed of delegates from various National Associations, unanimously voted to recommend it to their respective associations for approval or adoption; and is here presented by the National Board of Fire Underwriters with the various amendments and additions which have been made since that time by them.

The following is a list of the Associations composing the National Conference on Standard Electrical Rules:—

AMERICAN INSTITUTE OF ARCHITECTS.
AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
AMERICAN INSTITUTE OF MINING ENGINEERS.
AMERICAN STREET AND INTERURBAN RAILWAY ASSOCIATION.
ASSOCIATED FACTORY MUTUAL FIRE INS. CO'S.
ASSOCIATION OF EDISON ILLUMINATING COMPANIES.
INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
NATIONAL BOARD OF FIRE UNDERWRITERS.
NATIONAL ELECTRIC LIGHT ASSOCIATION.
NATIONAL ELECTRICAL CONTRACTORS' ASSOCIATION.
NATIONAL ELECTRICAL INSPECTORS' ASSOCIATION.
UNDERWRITERS' NATIONAL ELECTRIC ASSOCIATION.

TO CONTRACTORS.

This volume contains only the installation rules under Classes A, B, C and E, such as are required by the contractor "on the job," and is for general distribution.

Another volume is issued in a small edition containing requirements for the construction of approved devices and materials (Class D), and rules for Marine Wiring (Class F). This second volume will not be furnished for general distribution, as the semi-annual List of Approved Fittings will give the contractor all the information as to approved devices which he may need.

207754

GENERAL PLAN

GOVERNING THE ARRANGEMENT OF RULES.

CLASS A.—**STATIONS AND DYNAMO ROOMS. Includes Central Stations; Dynamo, Motor and Storage-Battery Rooms; Transformer Sub-stations, etc.** Rules 1 to 11.

CLASS B.—**OUTSIDE WORK, all systems and voltages.** Rules 12 to 13 A.

CLASS C.—**INSIDE WORK:—**

General Rules, all systems and voltages. Rules 14 to 17.

Constant-Current Systems. Rules 18 to 20.

Constant Potential Systems:—

General Rules, *all voltages.* Rules 21 to 23.

Low-Potential Systems, *550 volts or less.* Rules 24 to 34.

High-Potential Systems, *550 to 3,500 volts.* Rules 35 to 37.

Extra-High-Potential Systems, *over 3,500 volts.* Rules 38 and 39.

CLASS D.—**FITTINGS, MATERIALS AND DETAILS OF CONSTRUCTION, all systems and voltages.** Rules 40 to 63.

NOTE.—Class D is omitted from this pamphlet.

CLASS E. **MISCELLANEOUS.** Rules 64 to 67

CLASS F. **MARINE WORK.** Rules 68 to 83.

NOTE.—Class F is omitted from this pamphlet.

GENERAL SUGGESTIONS.

The following as well as the fine print notes in the rules are simply suggestions and explanations and are in no case to be considered by inspection departments as mandatory.

In all electric work, conductors, however well insulated, should always be treated as bare, to the end that under no conditions, existing or likely to exist, can a ground or short circuit occur, and so that all leakage from conductor to conductor, or between conductor and ground, may be reduced to the minimum.

In all wiring special attention should be paid to the mechanical execution of the work. Careful and neat running, connecting, soldering, taping of conductors, and securing and attaching of fittings, are specially conducive to security and efficiency, and are strongly advised.

In laying out an installation, except for constant current systems, every reasonable effort should be made to secure distribution centers located in easily accessible places, at which points the cut-outs and switches controlling the several branch circuits can be grouped for convenience and safety of operation. The load should be divided as evenly as possible among the branches, and all complicated and unnecessary wiring avoided.

The use of wire-ways for rendering concealed wiring permanently accessible is most heartily endorsed and recommended; and this method of accessible concealed construction is advised for general use.

Architects are urged, when drawing plans and specifications, to make provision for the channeling and pocketing of buildings for electric light or power wires, and also for telephone, district messenger and other signaling system wiring.

CLASS A.

STATIONS AND DYNAMO ROOMS.

Includes Central Stations, Dynamo, Motor and Storage-Battery Rooms, Transformer Sub-stations, Etc.

1. Generators.

a. Must be located in a dry place.

It is suggested that water-proof covers be provided, which may be used in case of emergency.

b. Must never be placed in a room where any hazardous process is carried on, nor in places where they would be exposed to inflammable gases or flyings of combustible materials.

c. Must, when operating at a potential in excess of 550 volts, have their base frames permanently and effectively grounded.

Must, when operating at a potential of 550 volts or less, be thoroughly insulated from the ground wherever feasible. Wooden base frames used for this purpose, and wooden floors which are depended upon for insulation where, for any reason, it is necessary to omit the base frames, must be kept filled to prevent absorption of moisture, and must be kept clean and dry.

Where frame insulation is impracticable, the Inspection Department having jurisdiction may, in writing, permit its omission, in which case the frame must be permanently and effectively grounded.

If desired high potential machines may be surrounded by an insulated platform, made of wood, mounted on insulating supports, and so arranged that a man must always stand upon it in order to touch any part of the machine.

1. Generators—Continued.

d. Constant potential generators, except alternating current machines and their exciters, must be protected from excessive current by safety fuses or equivalent devices of *approved* design.

For two-wire, direct-current generators, single pole protection will be considered as satisfying the above rule, provided the safety device is located in the lead not connected to the series winding. When supplying three-wire systems, the generators must be so arranged that these protective devices will come in the outside leads.

For three-wire, direct-current generators, a safety device must be placed in each armature, direct-current lead, or a double pole, double trip circuit breaker in each outside generator lead and corresponding equalizer connection.

e. Must each be provided with a name-plate, giving the maker's name, the capacity in volts and amperes, and the normal speed in revolutions per minute.

f. Terminal blocks when used on generators must be made of *approved* non-combustible, non-absorptive, insulating material, such as slate, marble or porcelain.

g. The use of soft rubber bushings to protect the lead wires coming through the frames of generators is permitted, except when installed where oils, grease, oily vapors or other substances known to have rapid deleterious effect on rubber, are present in such quantities and in such proximity with motor or dynamo as may cause such bushings to be liable to rapid destruction. In such cases hard wood properly filled, or preferably porcelain or micanite bushings must be used.

2. Conductors.

From generators to switchboards, rheostats or other instruments, and thence to outside lines:—

2. Conductors—Continued.

a. Must be in plain sight or readily accessible.

Wires from generator to switchboard may, however, be placed in a run-way in the brick or cement pier on which the generator stands. When protection against moisture is necessary, lead covered cable or iron conduit must be used.

b. Must have an *approved* insulating covering as called for by rules in Class "C" for similar work, except that in central stations, on exposed circuits, the wire which is used must have a heavy braided, non-combustible outer covering.

Bus bars may be made of bare metal.

Where a number of wires are brought close together, as is generally the case in dynamo rooms, especially about the switchboard, they must be surrounded with a tight, non-combustible outer cover.

Flame proofing must be stripped back on all cables a sufficient amount to give the necessary insulation distances for the voltage of the circuit on which the cable is used.

c. Must, where not in a conduit, be kept so rigidly in place that they cannot come in contact.

d. Must in all other respects be installed with the same precautions as required by rules in Class "C" for wires carrying a current of the same volume and potential.

e. In wiring switchboards, the ground detector voltmeter, pilot lights and potential transformers must be connected to a circuit of not less than No. 14 B. & S. gage wire that is protected by an *approved* fuse, this circuit is not to carry over 660 watts.

For the protection of instruments and pilot lights on switchboards, *approved* N. E. Code Standard Enclosed Fuses are preferred, but *approved* enclosed fuses of other designs of *not over two (2) amperes capacity*, may be used.

3. Switchboards.

a. Must be so placed as to reduce to a minimum the danger of communicating fire to adjacent combustible material.

Switchboards must not be built up to the ceiling, a space of three feet being left, if possible, between the ceiling and the board. The space back of the board must be kept clear of rubbish and not used for storage purposes.

b. Must be made of non-combustible material or of hardwood in skeleton form, filled to prevent absorption of moisture.

If wood is used all wires and all current carrying parts of the apparatus on the switchboard must be separated therefrom by non-combustible, non-absorptive, insulating material.

c. Must be accessible from all sides when the connections are on the back, but may be placed against a brick or stone wall when the wiring is entirely on the face.

If the wiring is on the back, there must be a clear space of at least eighteen inches between the wall and the apparatus on the board, and even if the wiring is entirely on the face, it is much better to have the board set out from the wall.

d. Must be kept free from moisture.

e. On switchboards the distances between bare live parts of opposite polarity must be made as great as practicable, and must not be less than those given for tablet-boards.

4. Resistance Boxes and Equalizers.

a. Must be placed on a switchboard, or at a distance of at least one foot from combustible material, or separated therefrom by a slab or panel of non-combustible, non-absorptive, insulating material such as slate, soapstone or marble, somewhat larger than the rheostat, which must be secured in position independently of the rheo-

4. Resistance Boxes and Equallzers—Continued.

stat supports. Bolts for supporting the rheostat shall be countersunk at least 1-8 inch below the surface at the back of the slab and filled. For proper mechanical strength, slab should be of a thickness consistent with the size and weight of the rheostat, and in no case to be less than 1-2 inch.

If resistance devices are installed in rooms where dust or combustible flyings would be liable to accumulate on them, they must be equipped with a dust-proof face plate.

b. Where protective resistances are necessary in connection with automatic rheostats, incandescent lamps may be used, provided that they do not carry or control the main current nor constitute the regulating resistance of the device.

When so used, lamps must be mounted in porcelain receptacles upon non-combustible supports, and must be so arranged that they cannot have impressed upon them a voltage greater than that for which they are rated. They must in all cases be provided with a name-plate, which shall be permanently attached beside the porcelain receptacle or receptacles and stamped with the candle-power and voltage of the lamp or lamps to be used in each receptacle.

c. Wherever insulated wire is used for connection between resistances and the contact plate of a rheostat, the insulation must be "slow burning." For large field rheostats and similar resistances, where the contact plates are not mounted upon them, the connecting wires may be run together in groups so arranged that the maximum difference of potential between any two wires in a group shall not exceed 75 volts. Each group of wires must either be mounted on non-combustible, non-absorptive insulators giving at least 1-2 inch separation from surface wired over, or, where it is necessary to protect the wires from mechanical injury or moisture, be run in *approved* lined conduit or equivalent.

5. Lightning Arresters.

a. Must be attached to each wire of every overhead circuit connected with the station.

b. Must be located in readily accessible places away from combustible materials, and as near as practicable to the point where the wires enter the building.

In all cases, kinks, coils and sharp bends in the wires between the arresters and the outdoor lines must be avoided as far as possible.

c. Must be connected with a thoroughly good and permanent ground connection by metallic strips or wires having a conductivity not less than that of a No. 6 B. & S. gage copper wire, which must be run as nearly in a straight line as possible from the arresters to the ground connection.

Ground wires for lightning arresters must not be attached to gas pipes within the buildings nor be run inside of iron pipes.

d. All choke coils or other attachments, inherent to the lightning protection equipment, shall have an insulation from the ground or other conductors equal at least to the insulation demanded at other points of the circuit in the station.

6. Care and Attendance.

a. A competent man must be kept on duty where generators are operating.

b. Oily waste must be kept in *approved* waste cans and removed daily.

7. Testing of Insulation Resistance.

a. All circuits except such as are permanently grounded in accordance with No. 13 A must be provided with reliable ground detectors. Detectors which indicate continuously and give an instant and permanent indication of a ground are preferable. Ground wires from detectors must not be attached to gas pipes within the building.

7. Testing of Insulation Resistance—Continued.

b. Where continuously indicating detectors are not feasible, the circuits should be tested at least once per day, and preferably oftener.

8. Motors.

When motors operating at a potential in excess of 550 volts are to be installed, it is suggested that plans for such installations should be submitted to the Inspection Department having jurisdiction before any work is begun.

a. Must, when operating at a potential in excess of 550 volts, have no exposed live metal parts, and have their base frames permanently and effectively grounded.

Motors operating at a potential of 550 volts or less must be thoroughly insulated from the ground wherever feasible. Wooden base frames used for this purpose, and wooden floors, which are depended upon for insulation where, for any reason, it is necessary to omit the base frames, must be kept filled to prevent absorption of moisture, and must be kept clean and dry. Where frame insulation is impracticable, the Inspection Department having jurisdiction may, in writing, permit its omission, in which case the frame must be permanently and effectively grounded.

If desired, high-potential machines may be surrounded with an insulated platform made of wood, mounted on insulating supports, and so arranged that a man must stand upon it in order to touch any part of the machine.

b. Motors operating at a potential of 550 volts or less must be wired with the same precautions as required by rules in Class "C" for wires carrying a current of the same volume.

Motors operating at a potential between 550 and 3,500 volts must be wired with approved multiple conductor, metal sheathed cable in approved unlined metal conduit firmly secured in

8. Motors—Continued.

place. The metal sheath must be permanently and effectively grounded, and the construction and installation of the conduit must conform to rules for interior conduits (see No. 25), except that at outlets approved outlet bushing shall be used.

The motor leads or branch circuits must be designed to carry a current at least 25 per cent greater than that for which the motor is rated. Where the wires under this rule would be overfused in order to provide for the starting current, as in the case of many of the alternating current motors, the wires must be of such size as to be properly protected by these larger fuses.

The insulation of the several conductors for high potential motors, where leaving the metal sheath at outlets, must be thoroughly protected from moisture and mechanical injury. This may be accomplished by means of a pot head or some equivalent method. The conduit must be substantially bonded to the metal casings of all fittings and apparatus connected to the inside high tension circuit.

Where outside wires directly enter the motor room the Inspection Department having jurisdiction may permit the wire for high potential motors to be installed according to the general rules for high potential systems.

c. Each motor and resistance box must be protected by a cut-out and controlled by a switch (see No. 17 *a*), said switch plainly indicating whether "on" or "off" (except as provided for electric cranes, see 34 *A–c*). With motors of one-fourth horse power or less, on circuits where the voltage does not exceed 300, No. 21 *d* must be complied with, and single pole switches may be used as allowed in No. 22 *c*. The switch and rheostat must be located within sight of the motor, except in cases where special permission to locate

8. Motors—Continued.

them elsewhere is given, in writing, by the Inspection Department having jurisdiction.

Where the circuit-breaking device on the motor-starting rheostat disconnects all wires of the circuit, the switch called for in this section may be omitted.

Overload-release devices on motor-starting rheostats will not be considered to take the place of the cut-out required by this section if they are inoperative during the starting of the motor.

An automatic circuit-breaker disconnecting all wires of the circuit may, however, serve as both switch and cut-out.

d. Rheostats must be so installed as to comply with *all* the requirements of No. 4. Auto starters must comply with requirements of No. 4 *c*.

Auto starters, unless equipped with tight casings enclosing all current-carrying parts, in all wet, dusty or linty places, must be enclosed in dust-tight, fireproof cabinets. Where there is any liability of short circuits across their exposed live parts being caused by accidental contacts, a railing must be erected around them.

e. Must not be run in series-multiple or multiple-series, except on constant-potential systems, and then only by special permission of the Inspection Department having jurisdiction.

f. Must be covered with a waterproof cover when not in use, and, if deemed necessary by the Inspection Department having jurisdiction, must be enclosed in an *approved* case.

Such enclosures must be readily accessible, dust proof and sufficiently ventilated to prevent an excessive rise of temperature. Where practicable the sides should be made largely of glass, so that the motor may be always plainly visible.

The use of enclosed type motor is recommended in dusty places, being preferable to wooden boxing.

8. Motors—Continued.

g. Must, when combined with ceiling fans, be hung from insulated hooks, or else there must be an insulator interposed between the motor and its support.

h. Must each be provided with a name-plate, giving the maker's name, the capacity in volts and amperes, and the normal speed in revolutions per minute.

i. Terminal blocks when used on motors must be made of *approved* non-combustible, non-absorptive, insulating material such as slate, marble or porcelain.

j. Adjustable speed motors, unless of special and appropriate design, if controlled by means of field regulation, must be so arranged and connected that they cannot be started under weakened field.

9. Railway Power Plants.

a. Each feed wire before it leaves the power plant must be protected by an *approved* automatic circuit-breaker or other device, which will immediately cut off the current in case of an accidental ground. This device must be mounted on a fire-proof base, and in full view and reach of the attendant.

10. Storage or Primary Batteries.

a. When current for light and power is taken from primary or secondary batteries, the same general regulations must be observed as apply to similar apparatus fed from dynamo generators developing the same difference of potential.

b. Storage battery rooms must be thoroughly ventilated.

c. Special attention is directed to the rules for wiring in rooms where acid fumes exist (see No. 24, *i* and *j*).

10. Storage or Primary Batteries—Continued.

d. All secondary batteries must be mounted on non-absorptive, non-combustible insulators, such as glass or thoroughly vitrified and glazed porcelain.

e. The use of any metal liable to corrosion must be avoided in cell connections of secondary batteries.

11. Transformers.

(*See also Nos, 13, 13 A, 36.*)

a. In central or sub-stations the transformers must be so placed that smoke from the burning out of the coils or the boiling over of the oil (where oil filled cases are used) could do no harm.

b. In central or sub-stations casings of all transformers must be permanently and effectively grounded.

Transformers used exclusively to supply current to switchboard instruments need not be grounded, provided they are thoroughly insulated.

OUTSIDE WORK.

(*Light, Power and Heat. For Signaling Systems, see Class E.*)

ALL SYSTEMS AND VOLTAGES.

12. Wires.

a. Line wires must have an *approved* weatherproof or rubber insulating covering. That portion of the service wires between the main cut-out and switch and the first support from the cut-out or switch on outside of the building must have an approved rubber insulating covering, but from the above-mentioned support to the line, except when run in conduit, may have an approved weatherproof insulating covering if kept free from awnings, swinging signs, shutters, etc.

b. Must be so placed that moisture cannot form a cross connection between them, and except when run in conduit, not less than a foot apart, and not in contact with any substance other than their insulating supports. Wooden blocks to which insulators are attached must be covered over their entire surface with at least two coats of waterproof paint.

For conduit work, wires must be placed so as to conform to rules for unlined conduit except that conduit system must be waterproof.

c. Must be at least seven feet above the highest point of flat roofs, and at least one foot above the ridge of pitched roofs over which they pass or to which they are attached and roof structures must be substantially constructed.

12. Wires—Continued.

d. (Stricken out.)

e. Must, where exposed to the weather, be provided with petticoat insulators of glass or porcelain; porcelain knobs or cleats and rubber hooks will not be approved. Wires on the exterior walls of buildings must be supported at least every fifteen feet, the distance between supports to be shortened if wires are liable to be disturbed.

Where not exposed to the weather, low potential wires may be supported on glass or porcelain knobs which will separate the wires at least one inch from the surface wired over, supports to be placed at least every four an one half feet.

f. Must be so spliced or joined as to be both mechanically and electrically secure without solder. The joints must then be soldered, to insure preservation, and covered with an insulation equal to that on the conductors.

All joints must be soldered, unless made with some form of *approved* splicing device.

g. Must, where they enter buildings, have drip loops outside, and the holes through which the conductors pass must be bushed with non-combustible, non-absorptive, insulating tubes slanting upward toward the inside.

For low potential systems the service wires may be brought into buildings through a single iron conduit. The conduit to be equipped with an *approved* service-head. The inner end must extend to the service cut-out, and if a cabinet is required by the Code must properly enter the cabinet.

h. Electric light and power wires must not be placed on the same cross-arm with telegraph, telephone or similar wires, and when placed on the same pole with such wires the distance between the two inside pins of each cross-arm must not be less than twenty-six inches.

i. The metallic sheaths to cables must be permanently and effectively connected to "earth."

12. Wires—Continued.

Trolley Wires.

j. Must not be smaller than No. 0 B. & S. gage copper or No. 4 B. & S. gage silicon bronze, and must readily stand the strain put upon them when in use.

k. Must have a double insulation from the ground. In wooden pole construction the pole will be considered as one insulation.

l. Must be capable of being disconnected at the power plant, or of being divided into sections, so that in case of fire on the railway route, the current may be shut off from the particular section and not interfere with the work of the firemen. This rule also applies to feeders.

m. Must be safely protected against accidental contact where crossed by other conductors.

Where guard wires are used they must be insulated from the ground and electrically disconnected in sections of not more than 300 feet in length.

Ground Return Wires.

n. For the diminution of electrolytic corrosion of underground metal work, ground return wires must be so arranged that the difference of potential between the grounded dynamo terminal and any point on the return circuit will not exceed twenty-five volts.

It is suggested that the positive pole of the dynamo be connected to the trolley line, and that whenever pipes or other underground metal work are found to be electrically positive to the rails or surrounding earth, that they be connected by conductors arranged so as to prevent as far as possible current flow from the pipes into the ground.

12 A. Constant-Potential Pole Lines, Over 5,000 Volts.

(Overhead lines of this class unless properly arranged may increase the fire loss from the following causes:—

Accidental crosses between such lines and low-potential lines may allow the high-voltage current to enter buildings over a large section of adjoining country. Moreover, such high-voltage lines, if carried close to buildings, hamper the work of firemen in case of fire in the building. The object of these rules is so to direct this class of construction that no increase in fire hazard will result, while at the same time care has been taken to avoid restrictions which would unreasonably impede progress in electrical development.

It is fully understood that it is impossible to frame rules which will cover all conceivable cases that may arise in construction work of such an extended and varied nature, and it is advised that the Inspection Department having jurisdiction be freely consulted as to any modification of the rules in particular cases.)

a. Every reasonable precaution must be taken in arranging routes so as to avoid exposure to contacts with other electric circuits. On existing lines, where there is a liability to contact, the route should be changed by mutual agreement between the parties in interest wherever possible.

b. Such lines should not approach other pole lines nearer than a distance equal to the height of the taller pole line, and such lines should not be on the same poles with other wires, except that signaling wires used by the Company operating the high-pressure system, and which do not enter property other than that owned or occupied by such Company, may be carried over the same poles.

c. Where such lines must necessarily be carried nearer to other pole lines than is specified in Section *b* above, or where they must necessarily be carried on the same poles with other wires, extra precautions to reduce the liability of a breakdown to a minimum must be taken, such as the use of wires of ample mechanical strength, widely

12 A. Constant-Potential Pole Lines, over 5,000 volts—Continued.

spaced cross-arms, short spans, double or extra heavy cross-arms, extra heavy pins, insulators, and poles thoroughly supported. If carried on the same poles with other wires, the high-pressure wires must be carried at least three feet above the other wires.

d. Where such lines cross other lines, the poles of both lines must be of heavy and substantial construction.

Whenever it is feasible, end-insulator guards should be placed on the cross-arms of the upper line. If the high-pressure wires cross below the other lines, the wires of the upper line should be dead-ended at each end of the span to double-grooved, or to standard transposition insulators, and the line completed by loops.

One of the following forms of construction must then be adopted:—

1. The height and length of the cross-over span may be made such that the shortest distance between the lower cross-arms of the upper line and any wire of the lower line will be greater than the length of the cross-over span, so that a wire breaking near one of the upper pins would not be long enough to reach any wire of the lower line. The high-pressure wires should preferably be above the other wires.
2. A joint pole may be erected at the crossing point, the high-pressure wires being supported on this pole at least three feet above the other wires. Mechanical guards or supports must then be provided, so that in case of the breaking of any upper wire, it will be impossible for it to come into contact with any of the lower wires.

12 A. Constant-Potential Pole Lines, over 5,000 volts—Continued.

Such liability of contact may be prevented by the use of suspension wires, similar to those employed for suspending aerial telephone cables, which will prevent the high-pressure wires from falling, in case they break. The suspension wires should be supported on high-potential insulators, should have ample mechanical strength, and should be carried over the high pressure wires for one span on each side of the joint pole, or where suspension wires are not desired guard wires may be carried above and below the lower wires for one span on each side of the joint pole, and so spread that a falling high-pressure wire would be held out of contact with the lower wires.

Such guard wires should be supported on high-potential insulators or should be grounded. When grounded, they must be of such size, and so connected and earthed, that they can surely carry to ground any current which may be delivered by any of the high-pressure wires. Further, the construction must be such that the guard wires will not be destroyed by any arcing at the point of contact likely to occur under the conditions existing.

3. Whenever neither of the above methods is feasible, a screen of wire should be interposed between the lines at the cross-over. This screen should be supported on high tension insulators or grounded, and should be of such construction and strength as to prevent the upper wires from coming into contact with the lower ones.

If the screen is grounded each wire of the screen must be of such size and so connected and earthed that it can surely carry to ground any current which may be delivered by any of the high-pressure wires. Further, the construction must be such that the wires of screen will not be destroyed by any arcing at the point of contact likely to occur under the conditions existing.

e. When it is necessary to carry such lines near buildings, they must be at such height and dis-

12 A. Constant-Potential Pole Lines, over 5,000 volts—Continued.

tance from the building as not to interfere with firemen in event of fire; therefore, if within 25 feet of a building, they must be carried at a height not less than that of the front cornice, and the height must be greater than that of the cornice, as the wires come nearer to the building in accordance with the following table:—

Distance of wire from building. Feet.	Elevation of wire above cornice of building. Feet.
25	0
20	2
15	4
10	6
5	8
2½	9

It is evident that where the roof of the building continues nearly in line with the walls, as in Mansard roofs, the height and distance of the line must be reckoned from some part of the roof instead of from the cornice.

13. Transformers.

(*See also Nos. 11, 13 A and 36.*)

Where transformers are to be connected to high-voltage circuits, it is necessary in many cases, for best protection to life and property, that the secondary system be permanently grounded, and provision should be made for it when the transformers are built.

a. Must not be placed inside of any building, excepting central stations and sub-stations (except as provided in No. 30 A), unless by special permission of the Inspection Department having jurisdiction.

b. Must not be attached to the outside walls of buildings, unless separated therefrom by substantial supports.

Must not be attached to frame buildings when any other location is practicable.

13 A. Grounding Low-Potential Circuits.

The grounding of low-potential circuits under the following regulations is only allowed when such circuits are so arranged that under normal conditions of service there will be no passage of current over the ground wire.

Direct-Current 3-Wire Systems.

a. Neutral wire may be grounded and when grounded the following rules nust be complied with:—

1. Must be grounded at the Central Station on a metal plate buried in coke beneath permanent moisture level, and also through all available underground water and gas pipe systems.
2. In underground systems the neutral wire must also be grounded at each distributing box through the box.
3. In overhead systems the neutral wire must be grounded every 500 feet, as provided in Sections *c* to *g*.

Inspection Departments having jurisdiction may *require* grounding if they deem it necessary.

Two-wire direct-current systems having no accessible neutral point are not to be grounded.

Alternating-Current Secondary Systems.

b. Transformer secondaries of distributing systems should preferably be grounded, and when grounded, the following rules must be complied with:—

1. The grounding must be made at the neutral point or wire, whenever a neutral point or wire is accessible.
2. When no neutral point or wire is accessible one side of the secondary circuit may be grounded, provided the maxi-

13 A. Grounding Low-Potential Circuits—Continued.

mum difference of potential between the grounded point and any other point in the circuit does not exceed 250 volts.

3. The ground connection must be at the transformers or on the individual service as provided in sections *c* to *g*, and when transformers feed systems with a neutral wire, the neutral wire must also be grounded at least every 250 feet for overhead systems, and every 500 feet for underground systems.

Inspection Departments having jurisdiction may *require* grounding if they deem it necessary.

Ground Connections.

c. When the ground connection is inside of any building, or the ground wire is inside of, or attached to any building (except Central or Sub-stations) the ground wire must be of copper and have an approved rubber insulating covering National Electrical Code Standard, for from 0 to 600 volts.

d. The ground wire in direct-current 3-wire systems must not at Central Stations be smaller than the neutral wire and not smaller than No. 4 B. & S. gage elsewhere. The ground wire in alternating-current systems must never be less than No. 4 B. & S. gage.

On three-phase system, the ground wire must have a carrying capacity equal to that of any one of the three mains.

e. The ground wire should, except for Central Stations and transformer sub-stations, be kept outside of buildings as far as practicable, but may be directly attached to the building or pole by cleats or straps or on porcelain knobs. Staples must never be used. The wire must be carried in as nearly a straight line as practicable, avoid-

13 A. Grounding Low-Potential Circuits—Continued.

ing kinks, coils and sharp bends, and must be protected when exposed to mechanical injury.

This protection can be secured by use of an approved moulding, and as a rule the ground wire on the outside of a building should be in moulding at all places where it is in within seven feet from the ground.

f. The ground connection for Central Stations, transformer sub-stations, and banks of transformers must be made through metal plates buried in coke below permanent moisture level, and connection should also be made to all available underground piping systems including the lead sheath of underground cables.

g. For individual transformers and building services, the ground connection may be made as in Section *f*, or may be made to water piping systems running into buildings. This connection may be made by carrying the ground wire into the cellar and connecting on the street side of meters, main cocks, etc.

Where it is necessary to run the ground wire through any part of a building it shall be protected by approved porcelain bushings through walls or partitions and shall be run in approved moulding, except that in basements it may be supported on porcelain.

In connecting a ground wire to a piping system, the wire should be sweat into a lug attached to an approved clamp, and the clamp firmly bolted to the water pipe after all rust and scale have been removed ; or be soldered into a brass plug and the plug forcibly screwed into a pipe-fitting, or where the pipes are cast iron, into a hole tapped into the pipe itself. For large stations, where connecting to underground pipes with bell and spigot joints, it is well to connect to several lengths, as the pipe joints may be of rather high resistance.

Where ground plates are used, a No 16 Stubbs' gage copper plate, about three by six feet in size, with about two feet of crushed coke or charcoal, about pea size, both under and over it, would make a ground of sufficient capacity for a moderate-sized station, and would probably answer for the ordinary sub-station or bank of trans-

13 A. Grounding Low-Potential Circuits—Continued.

formers. For a large central station, a plate with considerably more area might be necessary, depending upon the other underground connections available. The ground wire should be riveted to the plate in a number of places, and soldered for its whole length. Perhaps even better than a copper plate is a cast-iron plate with projecting forks, the idea of the fork being to distribute the connection to the ground over a fairly broad area, and to give a large surface contact. The ground wire can probably best be connected to such a cast-iron plate by soldering it into brass plugs screwed into holes tapped in the plate. In all cases, the joint between the plate and the ground wire should be thoroughly protected against corrosion by painting it with waterproof paint or some equivalent.

CLASS C.

INSIDE WORK.

(*Light, Power and Heat. For signaling Systems, see Class E.*)

ALL SYSTEMS AND VOLTAGES.

GENERAL RULES.

14. Wires.

a. Must not be of smaller size than No. 14 B. & S. gage, except as allowed for fixture work and pendant cord.

b. Tie wires must have an insulation equal to that of the conductors they confine. For wire smaller than No. 8 B. & S. gage split knobs or cleats shall be used except at dead ends, and tie wires and knobs will not be approved.

Screws must be used for fastening all cleats and knobs which are arranged to grip the wire.

c. Must be so spliced or joined as to be both mechanically and electrically secure without solder. The joints must then be soldered unless made with some form of *approved* splicing device, and covered with an insulation equal to that on the conductors.

Stranded wires (except in flexible cords) must be soldered before being fastened under clamps or binding screws, and whether stranded or solid, when they have a conductivity greater than that of No. 8 B. & S. gage they must be soldered into lugs for all terminal connections, except where an *approved* solderless terminal connector is used.

14. Wires—Continued.

d. Must be separated from contact with walls, floors, timbers or partitions through which they may pass by non-combustible, non-absorptive, insulating tubes, such as glass or porcelain, except at outlets where approved flexible tubing is required.

Bushings must be long enough to bush the entire length of the hole in one continuous piece, or else the hole must first be bushed by a continuous waterproof tube, This tube may be a conductor, such as iron pipe, but in that case an insulating bushing must be pushed into each end of it, extending far enough to keep the wire absolutely out of contact with the pipe.

e. Must be kept free from contact with gas, water or other metallic piping, or any other conductors or conducting material which they may cross, by some continuous and firmly fixed non-conductor, creating a permanent separation. Deviations from this rule may sometimes be allowed by special permission.

Where tubes are used they must be securely fastened at the ends to prevent them from moving along the wire.

f. Must be so placed in wet places that an air space will be left between conductors and pipes in crossing, and the former must be run in such a way that they cannot come in contact with the pipe accidentally. Wires should be run over, rather than under, pipes upon which moisture is likely to gather or which, by leaking, might cause trouble on a circuit.

g. The installation of electrical conductors in wooden moulding, or on insulators, in elevator shafts will not be approved, but conductors may be installed in such shafts if encased in approved metal conduits.

15. Underground Conductors.

a. Must be protected against moisture and mechanical injury where brought into a building, and all combustible material must be kept from the immediate vicinity.

b. Must not be so arranged as to shunt the current through a building around any catch-box.

c. Where underground service enters building through tubes, the tubes shall be tightly closed at outlets with asphaltum or other non-conductor, to prevent gases from entering the building through such channels.

d. No underground service from a subway to a building shall supply more than one building except by written permission from the Inspection Department having jurisdiction.

16. Table of Carrying Capacity of Wires.

a. The following table, showing the allowable carrying capacity of copper wires and cables of ninety-eight per cent conductivity, according to the standard adopted by the American Institute of Electrical Engineers, must be followed in placing interior conductors.

For insulated aluminum wire the safe carrying capacity is eighty-four per cent of that given in the following tables for copper wire with the same kind of insulation.

16. Table of Carrying Capacity of Wires—Continued.

B. & S. G.	Table A. Rubber Insulation. Amperes.	Table B. Other Insulations. Amperes.	Circular Mils.
18	3	5	1,624
16	6	8	2,583
14	12	16	4,107
12	17	23	6,530
10	24	32	10,380
8	33	46	16,510
6	46	65	26,250
5	54	77	33,100
4	65	92	41,740
3	76	110	52,630
2	90	131	66,370
1	107	156	83,690
0	127	185	105,500
00	150	220	133,100
000	177	262	167,800
0000	210	312	211,600
Circular Mils.			
200,000	200	300	
300,000	270	400	
400,000	330	500	
500,000	390	590	
600,000	450	680	
700,000	500	760	
800,000	550	840	
900,000	600	920	
1,000,000	650	1,000	
1,100,000	690	1,080	
1,200,000	730	1,150	
1,300,000	770	1,220	
1,400,000	810	1,290	
1,500,000	850	1,360	
1,600,000	890	1,430	
1,700,000	930	1,490	
1,800,000	970	1,550	
1,900,000	1,010	1,610	
2,000,000	1,050	1,670	

The lower limit is specified for rubber-covered wires to prevent gradual deterioration of the high insulations by the heat of the wires, but not from fear of igniting the insulation. The question of drop is not taken into consideration in the above tables.

The carrying capacity of Nos. 16 and 18, B. & S. gage wire is given, but no smaller than No. 14 is to be used, except as allowed under rules for fixture wiring.

17. Switches, Cut-outs, Circuit-Breakers, Etc.

a. On constant potential circuits, all service switches and all switches controlling circuits supplying current to motors or heating devices, and all fuses, unless otherwise provided (for exceptions as to switches see Nos. 8 *c*, 23 *a* and 34 *A*—*c*; for exceptions as to cuts-outs see No. 21 *a* and *b*) must be so arranged that the fuses will protect and the opening of the switch will disconnect all of the wires; that is, in the two-wire system the two wires, and the three-wire system the three wires, must be protected by the fuses and disconnected by the operation of the switch.

When installed without other automatic overload protective devices automatic overload circuit breakers must have the poles and trip coils so arranged as to afford complete protection against overloads and short circuits, and if also used in place of the switch must be so arranged that no one pole can be opened manually without disconnecting all the wires.

This, of course, does not apply to the grounded circuit of street railway systems.

b. Must not be placed in the immediate vicinity of easily ignitible stuff or where exposed to inflammable gases or dust or to flyings of combustible material.

When the occupancy of a building is such that switches, cut-outs, etc., cannot be located so as not to be exposed to dust or flyings of combustible material they must be enclosed in approved dust-proof cabinets with self-closing doors, except oil switches and circuit breakers which have dust-tight casings.

c. Must, when exposed to dampness, either be enclosed in a moisture-proof box or mounted on porcelain knobs. The cover of the box must be so made that no moisture which may collect on the top or sides of the box can enter it.

d. Time switches, sign flashers and similar appliances must be of approved design and enclosed in an *approved* cabinet.

CONSTANT-CURRENT SYSTEMS.

PRINCIPALLY SERIES ARC LIGHTING.

18. Wires.

(*See also Nos. 14, 15 and 16.*)

a. Must have an *approved* rubber insulating covering.

b. Must be arranged to enter and leave the building through an *approved* double-contact service switch, mounted in a non-combustible case, kept free from moisture, and easy of access to police or firemen.

c. Must always be in plain sight, and never encased, except when *required* by the Inspection Department having jurisdiction.

d. Must be supported on glass or porcelain insulators, which separate the wire at least one inch from the surface wired over and must be kept *rigidly* at least eight inches from each other, except within the structure of lamps, on hanger-boards or in cut-out boxes, or like places, where a less distance is necessary.

e. Must, on side walls be protected from mechanical injury by a substantial boxing, retaining an air space of one inch around the conductors, closed at the top (the wires passing through bushed holes), and extending not less than seven feet from the floor. When crossing floor timbers in cellars, or in rooms where they might be exposed to injury, wires must be attached by their insulating supports to the under side of a wooden strip not less than one-half an inch in thickness. Instead of the running-boards, guard strips on

18. Wires—Continued.

each side of and close to the wires will be accepted. These strips to be not less than seven-eighths of an inch in thickness and at least as high as the insulators.

19. Series Arc Lamps.

a. Must be carefully isolated from inflammable material.

b. Must be provided at all times with a glass globe surrounding the arc, and securely fastened upon a closed base. Broken or cracked globes must not be used.

c. Must be provided with a wire netting (having a mesh not exceeding one and one-fourth inches) around the globe, and an *approved* spark arrester when readily inflammable material is in the vicinity of the lamps, to prevent escape of sparks of carbon or melted copper.

Outside arc lamps must be suspended at least eight feet above sidewalks. Inside arc lamps must be placed out of reach or suitably protected.

Arc lamps, when used in places where they are exposed to flyings of easily inflammable material, must have the carbons enclosed completely in a tight globe in such manner as to avoid the necessity for spark arresters.

"Enclosed arc" lamps, having tight inner globes, may be used, and the requirements of Sections *b* and *c* above would, of course, not apply to them.

d. Where hanger-boards are not used, lamps must be hung from insulating supports other than their conductors.

e. Lamps when arranged to be raised and lowered, either for carboning or other purposes, shall be connected up with stranded conductors from the last point of support to the lamp, when such conductor is larger than No. 14 B. & S. gage.

20. Incandescent Lamps in Series Circuits.

a. Must have the conductors installed as required in No. 18, and each lamp must be provided with an automatic cut-out.

b. Must have each lamp suspended from a hanger-board by means of rigid tube.

c. No electro-magnetic device for switches and no multiple-series or series-multiple system of lighting will be approved.

d. Must not under any circumstances be attached to gas fixtures.

CONSTANT-POTENTIAL SYSTEMS.

GENERAL RULES—ALL VOLTAGES.

21. Automatic Cut-outs (Fuses and Circuit-Breakers).

(*See also No. 17.*)

a. Must be placed on all service wires, either overhead or underground, in the nearest accessible place to the point where they enter the building and inside the walls, and arranged to cut off the entire current from the building.

Where the switch required by No. 22 *a* is inside the building, the cut-out required by this section must be placed so as to protect it.

For three-wire (not three-phase) systems the fuse in the neutral wire may be omitted, provided the neutral wire is of equal carrying capacity to the larger of the outside wires, and is grounded as provided for in No. 13 A.

In risks having private plants, the yard wires running from building to building are not considered as service wires, so that cut-outs would not be required where the wires enter buildings, provided that the next fuse back is small enough to properly protect the wires inside the building in question.

b. Must be placed at every point where a change is made in the size of wire [unless the cut-out in the larger wire will protect the smaller (see No. 16.)]

For three-wire (not three-phase) systems the fuse in the neutral wire except that called for under No. 21 d, may be omitted, provided the neutral wire is of equal carrying capacity to the larger

21. Automatic Cut-outs—Continued.

of the outside wires, and is grounded as provided for in No. 13 A.

c. Must be in plain sight, or enclosed in an *approved* cabinet, and readily accessible. They must not be placed in the canopies or shells of fixtures.

Link fuses may be used only when mounted on *approved* slate or marble bases and must be enclosed in dust-tight, fire-proofed cabinets, except on switchboards.

d. Must be so placed that no set of incandescent lamps requiring more than 660 watts, whether grouped on one fixture or on several fixtures or pendants, will be dependent upon one cut-out.

Special permission may be given in writing by the Inspection Department having jurisdiction, for departure from this rule, in the case of large chandeliers. (For exceptions, see rule on theatre wiring and List of Fittings for rules for electric signs.) All branches or taps from any three-wire system which are directly connected to lamp sockets or other translating devices, must be run as two-wire circuits if the fuses are omitted in the neutral, or if the difference of potential between the two outside wires is over 250 volts, and both wires of such branch or tap circuits must be protected by proper fuses.

The above shall also apply to motors when more than one is dependent on a single cut-out.

The fuses in the branch cut-outs must not have a rated capacity greater than 6 amperes on 110 volt systems, and 3 amperes on 220 volt systems.

On open work in large mills *approved* link fused rosettes may be used at a voltage of not over 125 and *approved* enclosed fused rosettes at a voltage of not over 250, the fuse in the rosettes not to exceed 3 amperes, and a fuse of over 25 amperes must not be used in the branch circuit.

e. The rated capacity of fuses must not exceed the allowable carrying capacity of the wire as given

21. Automatic Cut-outs—Continued.

in No. 16. Circuit-breakers must not be set more than 30 per cent above allowable carrying capacity of the wire, unless a fusible cut-out is also installed on the circuit, in which event the circuit-breaker may be set as high as 100 per cent above such capacity.

In the arms of fixtures carrying a single socket a No. 18 B. & S. gage wire supplying only one socket will be considered as properly protected by a six ampere fuse.

f. Each phase of A. C. motor circuits, except on main switchboard or when otherwise subject to expert supervision, must be protected by an *approved* fuse whether automatic overload circuit breakers are installed or not. Single phase motors may have one side protected by an *approved* automatic overload circuit breaker only if the other side is protected by an *approved* fuse. For circuits having a maximum capacity greater than that for which enclosed fuses are approved circuit breakers alone will be approved.

22. Switches.

(*See No. 17.*)

a. Must be placed on all service wires, either overhead or underground, in the nearest readily accessible place, to the point where the wires enter the building, and arranged to cut off the entire current.

Service cut-out and switch must be arranged to cut off current from all devices including meters.

In risks having private plants the yard wires running from building to building are not considered as service wires, so that switches would not be required in each building if there are other switches conveniently located on the mains or if the generators are near at hand.

22. Switches—Continued.

b. Must always be placed in dry, accessible places, and be grouped as far as possible. (See No. 17 *c.*) Single-throw knife switches must be so placed that gravity will not tend to close them. Double-throw knife switches may be mounted so that the throw will be either vertical or horizontal as preferred.

When practicable switches must be so wired that blades will be "dead" when switch is open.

When switches are used in rooms where combustible flyings would be likely to accumulate around them, they must be enclosed in dust-tight cabinets.

Up to 250 volts and thirty amperes, *approved indicating snap* switches are suggested in preference to knife switches on lighting circuits.

c. Single pole switches must never be used as service switches nor placed in the neutral wire of a three-wire system, except in the two-wire branch or tap circuit supplying not more than 660 watts.

This, of course, does not apply to the grounded circuits of Street Railway systems.

Three-way switches are considered as single pole switches and must be wired so that only one pole of the circuit is carried to either switch.

d. Where flush switches or receptacles are used, whether with conduit systems or not, they must be enclosed in an *approved* box constructed of iron or steel, in addition to the porcelain enclosure of the switch or receptacle. No push buttons for bells, gas-lighting circuits, or the like shall be placed in the same wall plate with switches controlling electric light or power wiring.

e. Where possible, at all switch or fixture outlets, unless outlet boxes which will give proper support for fixtures are used, a 7-8 inch block must be fastened between studs or floor timbers

22, Switches—Continued.

flush with the back of lathing to hold tubing, and to support switches or fixtures. When this cannot be done, wooden base blocks, not less than 3-4 inch in thickness, securely screwed to lathing, must be provided for switches, and also for fixtures which are not attached to gas pipes or conduit.

f. Sub-bases of non-combustible, non-absorptive, insulating material, which will separate the wires at least 1-2 inch from the surface wired over, must be installed under all snap switches used in exposed knob and cleat work. Sub-bases must also be used in moulding work, but they may be made of hardwood or they may be omitted if the switch is approved for mounting directly on the moulding.

23. Electric Heaters.

It is often desirable to connect in multiple with the heaters and between the heater and the switch controlling same, an incandescent lamp of low candle power, as it shows at a glance whether or not the switch is open, and tends to prevent its being left closed through oversight.

a. Must be protected by a cut-out and controlled by indicating switches. Switches must be double pole except when the device controlled does not require more than 660 watts of energy.

b. Must never be concealed, but must at all times be in plain sight. Special permission may be given in writing by the Inspection Department having jurisdiction for departure from this rule.

c. Flexible conductors for smoothing irons and sad irons, and for all devices requiring over 250 watts must have an *approved* insulation and covering.

d. For portable heating devices the flexible conductors must be connected to an *approved* plug device, so arranged that the plug will pull out

23. Electric Heaters—Continued.

and open the circuit in case any abnormal strain is put on the flexible conductor. This device may be stationary, or it may be placed in the cord itself. The cable or cord must be attached to the heating apparatus in such manner that it will be protected from kinking, chafing or like injury at or near the point of connection.

e. Smoothing irons, sad irons, and other heating appliances that are intended to be applied to inflammable articles, such as clothing, must conform to the above rules so far as they apply. They must also be provided with an approved stand, on which they should be placed when not in use.

f. Stationary electric heating apparatus, such as radiators, ranges, plate warmers, etc., must be placed in a safe location, isolated from inflammable materials, and be treated as sources of heat.

Devices of this description will often require a suitable heat-resisting material placed between the device and its surroundings. Such protection may best be secured by installing two or more plates of tin or sheet steel with a one-inch air space between or by alternate layers of sheet steel and asbestos with a similar air space.

g. Must each be provided with name-plate, giving the maker's name and the normal capacity in volts and amperes.

LOW-POTENTIAL SYSTEMS.

550 VOLTS OR LESS.

Any circuit attached to any machine, or combination of machines, which develops a difference of potential between any two wires, of over ten volts and less than 550 volts, shall be considered as a low-potential circuit, and as coming under this class, unless an approved transforming device is used, which cuts the difference of potential down to ten volts or less. The primary circuit not to exceed a potential of 3,500 volts unless the primary wires are installed in accordance with the requirements as given in No. 12 A, or are underground. For 550 volt motor equipments a margin of ten per cent above the 550 volt limit will be allowed at the generator or transformer.

24. Wires.

GENERAL RULES.

(*See also Nos. 14, 15 and 16.*)

a. Where entering cabinets must be protected by approved bushings, which fit tightly the holes in the box and are well secured in place. The wires should completely fill the holes in the bushings so as to keep out the dust, tape being used to build up the wires if necessary. On concealed knob and tube work approved flexible tubing will be accepted in lieu of bushings, providing it shall extend from the last porcelain support into the cabinet.

b. Must not be laid in plaster, cement or similar finish, and must never be fastened with staples.

24. Wires—Continued.

c. Must not be fished for any great distance, and only in places where the inspector can satisfy himself that the rules have been complied with.

d. Twin wires must never be used, except in conduits, or where flexible conductors are necessary.

e. Must be protected on side walls from mechanical injury. When crossing floor timbers in cellars, or in rooms where they might be exposed to injury, wires must be attached by their insulating supports to the under side of a wooden strip, not less than one-half inch in thickness, and not less than three inches in width. Instead of the running-boards, guard strips on each side of and close to the wires will be accepted. These strips to be not less than seven-eighths of an inch in thickness, and at least as high as the insulators.

Protection on side walls must extend not less than five feet from the floor and must consist of substantial boxing, retaining an air space of one inch around the conductors, closed at the top (the wires passing through bushed holes) or *approved* metal conduit or pipe of equivalent strength.

When metal conduit or pipe is used, the insulation of each wire must be reinforced by *approved* flexible tubing extending from the insulator next below the pipe to the one next above it, unless the conduit is installed according to No. 25 (sections *c* and *f* excepted), and the wire is approved for conduit use. The two or more wires of a circuit *each* with its flexible tubing (when required), if carrying alternating current *must*, or if direct current, *may* be placed within the same pipe.

In damp places the wooden boxing may be preferable because of the precautions which would be necessary to secure proper insulation if the pipe were used. With this exception, however, iron piping is considered preferable to the wooden boxing, and its use is strongly urged. It is especially suitable for the protection of wires near belts, pulleys, etc.

24. Wires—Continued.

f. When run in unfinished attics, will be considered as concealed, and when run in close proximity to water tanks or pipes, will be considered as exposed to moisture.

In unfinished attics wires are considered as exposed to mechanical injury, and must not be run on knobs on upper edge of joists.

SPECIAL RULES.

For Open Work.

In dry places.

g. Must have an *approved* rubber, slow-burning weatherproof, or slow-burning insulation.

A slow-burning covering, that is, one that will not carry fire, is considered good enough where the wires are entirely on insulating supports. Its main object is to prevent the copper conductors from coming accidentally into contact with each other or anything else.

h. Must be rigidly supported on non-combustible, non-absorptive insulators, which will separate the wires from each other and from the surface wired over in accordance with the following table:—

Voltage.	Distance from Surface.	Distance between Wires.
0 to 300	½ inch	2½ inch
301 to 550	1 inch	4 inch

Rigid supporting requires under ordinary conditions, where wiring along flat surfaces, supports at least every four and one-half feet. If the wires are liable to be disturbed, the distance between supports must be shortened. In buildings of mill construction, mains of not less than No. 8 B. & S. gage, where not liable to be disturbed, may be separated about six inches, and run from timber to timber, not breaking around, and may be supported at each timber only.

The neutral of an Edison three-wire system may

24. Wires—Continued.

be placed in the center of a three-wire cleat where the difference of potential between the outside wires is not over 300 volts, provided the outside wires are separated two and one-half inches.

Must not be "dead-ended" at a rosette socket or receptacle unless the last support is within twelve inches of the same.

In damp places, or buildings specially subject to moisture or to acid or other fumes liable to injure the wires or their insulation.

i. Must have an *approved* insulating covering.

For protection against water, rubber insulation must be used. For protection against corrosive vapors, either weatherproof or rubber insulation must be used.

j. Must be rigidly supported on non-combustible, non-absorptive insulators, which separate the wire at least one inch from the surface wired over, and must be kept apart at least two and one-half inches for voltages up to 300, and four inches for higher voltages.

Rigid supporting requires under ordinary conditions, where wiring over flat surfaces, supports at least every four and one-half feet. If the wires are liable to be disturbed, the distance between supports must be shortened. In buildings of mill construction, mains of not less than No. 8 B. & S. gage, where not liable to be disturbed, may be separated about six inches, and run from timber to timber, not breaking around, and may be supported at each timber only.

For Moulding Work (Wooden and Metal).

(*See No. 25 A.*)

k. Must have an *approved* rubber insulating covering, and must be in continuous lengths from outlet to outlet, or from fitting to fitting, no joints

24. Wires—Continued.

or taps to be made in moulding. Where branch taps are necessary in moulding work *approved* fittings for this purpose must be used.

l. Must never be placed in either metal or wooden moulding in concealed or damp places, or where the difference of potential between any two wires in the same moulding is over 300 volts. *Metal* mouldings must not be used for circuits requiring more than 660 watts of energy.

m. Must for alternating current systems if in metal moulding have the two or more wires of a circuit installed in the same moulding.

It is suggested that this be done for direct current systems also, so that they may be changed to alternating systems at any time, induction troubles preventing such a change if the wires are in separate mouldings.

For Conduit Work.

n. Must have an *approved* rubber insulating covering.

o. Must not be drawn in until all mechanical work on the building has been, as far as possible, completed.

Conductors in vertical conduit risers must be supported within the conduit system in accordance with the following table:—

No. 14 to 0 every 100 feet.
No. 00 to 0000 every 80 feet.
0000 to 350,000 C. M. every 60 feet.
350,000 C. M. to 500,000 C. M. every 50 feet.
500,000 C. M. to 750,000 C. M. every 40 feet.
750,000 C. M. every 35 feet.

The following methods of supporting cables are recommended:—

1. A turn of 90 degrees in the conduit system will constitute a satisfactory support.
2. Junction boxes may be inserted in the conduit system at the required intervals, in

24. Wires—Continued.

which insulating supports of *approved* type must be installed and secured in a satisfactory manner so as to withstand the weight of the conductors attached thereto, the boxes to be provided with proper covers.

3. Cables may be supported in *approved* junction boxes on two or more insulating supports so placed that the conductors will be deflected at an angle of not less than 90 degrees, and carried a distance of not less than twice the diameter of the cable from its vertical position. Cables so suspended may be additionally secured to these insulators by tie wires.

Other methods, if used, must be approved by the Inspection Departments having jurisdiction.

p. Must, for alternating systems, have the two or more wires of a circuit drawn in the same conduit.

It is suggested that this be done for direct current systems also, so that they may be changed to alternating systems at any time, induction troubles preventing such a change if the wires are in separate conduits.

The same conduit must not contain more than four two-wire, or three three-wire circuits of the same system, except by special permission of the Inspection Department having jurisdiction, and must never contain circuits of different systems.

For Concealed "Knob and Tube" Work.

q. Must have an *approved* rubber insulating covering.

r. Must be rigidly supported on non-combustible, non-absorptive insulators which separate the wire at least one inch from the surface wired over. Should preferably be run singly on sep-

24. Wires—Continued.

arate timbers, or studding, and must be kept at least five inches apart.

Must be separated from contact with the walls, floor timbers and partitions through which they may pass by non-combustible, non-absorptive, insulating tubes, such as glass or porcelain. Wires passing through timbers at the bottom of plastered partitions must be protected by an additional tube extending at least four inches above the timber.

Rigid supporting requires, under ordinary conditions, where wiring along flat surface, supports at least every four and one-half feet. If the wires are liable to be disturbed the distance between supports must be shortened.

At distributing centers, outlets or switches where space is limited and the five-inch separation cannot be maintained, each wire must be separately encased in a continuous length of approved flexible tubing.

s. When in a concealed knob and tube system, it is impracticable to place the whole of a circuit on non-combustible supports of glass or porcelain, that portion of the circuit which cannot be so supported must be installed with *approved* metal conduit, or *approved* armored cable, except that if the difference of potential between the wires is not over 300 volts, and if the wires are not exposed to moisture, they may be fished if separately encased in *approved* flexible tubing, extending in continuous lengths from porcelain support to porcelain support, from porcelain support to outlet, or from outlet to outlet.

t. When using either conduit or armored cable in mixed concealed knob and tube work, the requirements for conduit work or armored cable work must be complied with as the case may be.

u. Must at all outlets, except where conduit is used, be protected by *approved* flexible tubing,

24. Wires—Continued.

extending in continuous lengths from the last porcelain support to at least one inch beyond the outlet. In the case of combination fixtures the tubes must extend at least flush with outer end of gas cap.

When the surface at any outlet is broken, it must be repaired so as to leave no holes or open spaces at such outlet.

It is suggested that *approved* outlet boxes or plates be installed at all outlets in concealed "knob and tube" work, the wires to be protected by *approved* flexible tubing, extending in continuous lengths from the last porcelain support into the box.

For Fixture Work.

v. Must have an *approved* rubber insulating covering, and be not less in size than No. 18 B. & S. gage.

In wiring certain designs of show-case fixtures, ceiling bulls-eyes and similar appliances in which the wiring is exposed to temperatures in excess of 120 degrees Fahrenheit (49 degrees Centigrade), from the heat of the lamps, *approved* slow-burning wire may be used. All such forms of fixtures must be submitted for examination, test and approval before being introduced for use.

w. Supply conductors, and especially the splices to fixture wires, must be kept clear of the grounded part of gas pipes, and, where shells or outlet boxes are used, they must be made sufficiently large to allow the fulfillment of this requirement.

x. Must, when fixtures are wired outside, be so secured as not to be cut or abraded by the pressure of the fastenings or motion of the fixture.

y. Wires of different systems must never be contained in or attached to the same fixture and under no circumstances must there be a difference of potential of more than 300 volts between wires contained in or attached to the same fixture.

24 A. Armored Cables.

a. Must be continuous from outlet to outlet or to junction boxes, and the armor of the cable must properly enter and be secured to all fittings, and the entire system must be mechanically secured in position.

In case of service connections and main runs, this involves running such armored cable continuously into a main cut-out cabinet or gutter surrounding the panel board, as the case may be.

b. Must be equipped at every outlet with an *approved* outlet box or plate, as required in conduit work.

Outlet plates must not be used where it is practicable to install outlet boxes.

The outlet box or plate shall be so installed that it will be flush with the finished surface, and if this surface is broken it shall be repaired so that it will not show any gaps or open spaces around the edge of the outlet box or plate.

In buildings already constructed where the conditions are such that neither outlet box nor plate can be installed, these appliances may be omitted by special permission of the Inspection Department having jurisdiction, provided the armored cable is firmly and rigidly secured in place.

c. Must have the metal armor of the cable permanently and effectively grounded.

Armor of cables and gas pipes must be securely fastened in metal outlet boxes so as to secure good electrical connection. Where boxes used for centers of distribution do not afford good electrical connection the armor of the cables must be joined around them by suitable bond wires. Where sections of armored cable are installed without being fastened to the metal structure of buildings or grounded metal piping, they must be bonded together and joined to a permanent and efficient ground connection.

24 A. Armored Cables—Continued.

It is suggested that cables, outlet boxes and fittings having conductive coatings be used in order to secure better electrical contact at all points throughout the cable system.

d. When installed in so-called fireproof buildings in course of construction or afterwards if exposed to moisture, or where it is exposed to the weather, or in damp places such as breweries, stables, etc., the cable must have a lead covering at least one thirty-second inch in thickness placed between the outer braid of the conductors and the steel armor.

The lead covering is not to be required when the cable is run against brick walls or laid in ordinary plaster walls unless same are continuously damp.

e. Where entering junction boxes, and at all other outlets, etc., must be provided with *approved* terminal fittings which will protect the insulation of the conductors from abrasion, unless such junction or outlet boxes are specially designed and approved for use with the cable.

f. Junction boxes must always be installed in such a manner as to be accessible.

g. For alternating current systems must have the two or more conductors of the cable enclosed in one metal armor.

h. All bends must be so made that the armor of the cable will not be injured. The radius of the curve of the inner edge of any bend not to be less than 1½ inches.

25. Interior Conduits.

(*See also No. 24 n to p.*)

a. No conduit tube having an internal diameter of less than five-eighths of an inch shall be used. Measurements to be taken inside of metal conduits.

b. Must be continuous from outlet to outlet or

25. Interior Conduits—Continued.

to junction boxes, and the conduit must properly enter, and be secured to all fittings and the entire system must be mechanically secured in position.

In case of service connections and main runs, this involves running each conduit continuously into a main cut-out cabinet or gutter surrounding the panel board, as the case may be.

c. Must be first installed as a complete conduit system, without the conductors.

d. Must be equipped at every outlet with an *approved* outlet box or plate.

Outlet plates must not be used where it is practicable to install outlet boxes.

The outlet box or plate must be so installed that it will be flush with the finished surface, and if this surface is broken it shall be repaired so that it will not show any gaps or open spaces around the edge of the outlet box or plate.

In buildings already constructed where the conditions are such that neither outlet box nor plate can be installed, these appliances may be omitted by special permission of the Inspection Department having jurisdiction, providing the conduit ends are bushed and secured.

It is suggested that outlet boxes and fittings having conductive coatings be used in order to secure better electrical contact at all points throughout the conduit system.

e. Metal conduits where they enter junction boxes, and at all other outlets, etc., must be provided with *approved* bushings or fastening plates fitted so as to protect wire from abrasion, except when such protection is obtained by the use of *approved* nipples, properly fitted in boxes or devices.

f. Must have the metal of the conduit permanently and effectually grounded.

Conduits and gas pipes must be securely fastened in metal outlet boxes so as to secure good

25. Interior Conduits—Continued.

electrical connection. If conduit, couplings, outlet boxes or fittings having protective coating of non-conducting material, such as enamel, are used, such coating must be thoroughly removed from threads of both couplings and conduit and from surfaces of boxes and fittings where the conduit is secured in order to obtain the requisite good connection. Where boxes used for centers of distribution do not afford good electrical connection, the conduits must be joined around them by suitable bond wires. Where sections of metal conduit are installed without being fastened to the metal structure of buildings or grounded metal piping, they must be bonded together and joined to a permanent and efficient ground connection.

g. Junction boxes must always be installed in such a manner as to be accessible.

h. All elbows or bends must be so made that the conduit or lining of same will not be injured. The radius of the curve of the inner edge of any elbow not to be less than three and one-half inches. Must have not more than the equivalent of four quarter bends from outlet to outlet, the bends at the outlets not being counted.

25 A. Metal Mouldings.

(*See also No. 24 k to m.*)

a. Must be continuous from outlet to outlet, to junction boxes, or approved fittings designed especially for use with metal mouldings, and must at all outlets be provided with approved terminal fittings which will protect the insulation of conductors from abrasion, unless such protection is afforded by the construction of the boxes or fittings.

b. Such moulding where passing through a floor must be carried through an iron pipe extending

25 A. Metal Mouldings—Continued.

from the ceiling below to a point five feet above the floor, which will serve as an additional mechanical protection and exclude the presence of moisture often prevalent in such locations.

In residences, office buildings and similar locations where appearance is an essential feature, and where the mechanical strength of the moulding itself is adequate, this ruling may be modified to require the protecting piping from the ceiling below to a point at least three inches above the flooring.

c. Backing must be secured in position by screws or bolts, the heads of which must be flush with the metal.

d. The metal of the moulding must be permanently and effectively grounded, and must be so installed that adjacent lengths of moulding will be mechanically and electrically secured at all points.

Mouldings and gas pipes must be securely fastened in metal outlet boxes, so as to secure good electrical connection. Where boxes used for center of distribution do not afford good electrical connection the metal moulding must be joined around them by suitable bond wires. Where sections are installed without being fastened to the metal structure of the building or grounded metal piping, they must be bonded together or joined to a permanent and effective ground connection.

It is suggested that outlet boxes and fittings having conductive coatings be used in order to secure better electrical contact at all points throughout the conduit system.

e. Must be installed so that for alternating systems the two or more wires of a circuit will be in the same metal moulding.

It is suggested that this be done for direct systems also, so that they may be changed to the alternating system at any time, induction troubles preventing such change if the wires are be in separate mouldings.

26. Fixtures.

(*See also Nos. 22 e, 24 v to y.*)

a. Must when supported from the gas piping or any grounded metal work of a building be insulated from such piping or metal work by means of *approved* insulating joints placed as close as possible to the ceiling or walls.

In straight electric fixtures where the insulation of conductors and the metal of fixtures are the equivalent of a conduit or armored cable system, or where used with approved wireless clusters or where the double braided wire extends directly into an *approved* porcelain socket, the insulating joint may be omitted.

Gas outlet pipes must be protected above the insulating joint by *approved* insulating tubing, and where outlet tubes are used they must be of sufficient length to extend below the insulating joint, and must be so secured that they will not be pushed back when the canopy is put in place.

Fixture canopies in fireproof buildings must be thoroughly and permanently insulated from walls or ceilings, and in other than fireproof buildings they must be thoroughly and permanently insulated from metal walls or ceilings or from plaster walls or ceilings on metal lathing.

b. Must have all burs or fins removed before the conductors are drawn into the fixture.

c. Must be free from "contacts" between conductors and fixture, "short circuits" and ground connections, and must be tested for such conditions before being connected to the supply conductors.

d. All fixture arms made of tubing smaller than 1-2 inch outside diameter, also the arms of all one-light brackets, must be secured after they are screwed into position by the use of a set-screw properly placed, or by soldering or cementing or

26. Fixtures—Continued.

some equally good method to prevent the arms from becoming unscrewed. Arms must not be made of tubing lighter than No. 18 B. & S. gage, and must have at screw joints not less than five threads all engaging. This rule does not apply to fixtures or brackets with cast or heavy arms.

e. The so-called flat canopy sometimes used on electric and combination fixtures will not be approved except in connection with outlet boxes.

f. Must, when installed on the outside of frame buildings, be of water-tight construction.

g. Must not, when wired on the outside, be used in show windows or in the immediate vicinity of especially inflammable stuff.

27. Sockets.

a. In rooms where inflammable gases may exist the incandescent lamp and socket must be enclosed in a vapor-tight globe, and supported on a pipe-hanger, wired with *approved* rubber-covered wire soldered directly to the circuit.

b. In damp or wet places "waterproof" sockets must be used. Unless made up on fixtures they must be hung by separate *stranded* rubber-covered wires not smaller than No. 14 B. & S. gage, which should preferably be twisted together when the pendent is over three feet long.

These wires must be soldered direct to the circuit wires but supported independently of them.

c. Key sockets will not be approved if installed over specially inflammable stuff, or where exposed to flyings of combustible material.

28. Flexible Cord.

a. Must have an *approved* insulation and covering.

b. Must not, except in street railway property, be used where the difference of potential between the two wires is over 300 volts.

28. Flexible Cord—Continued.

c. Must not be used as a support for clusters.

d. Must not be used except for pendants, wiring of fixtures, portable lamps or motors, and portable heating apparatus.

For all portable work, including those pendants which are liable to be moved about sufficiently to come in contact with surrounding objects, flexible wires and cables especially designed to withstand this severe service must be used.

When necessary to prevent portable lamps from coming in contact with inflammable materials, or to protect them from breakage, they must be surrounded with a substantial wire guard.

e. Must not be used in show windows or show cases except when provided with an *approved* metal armor.

f. Must be protected by insulating bushings where the cord enters the socket.

g. Must be so suspended that the entire weight of the socket and lamp will be borne by some *approved* method under the bushing in the socket, and above the point where the cord comes through the ceiling block or rosette, in order that the strain may be taken from the joints and binding screws.

29. Arc Lamps on Constant-Potential Circuits.

a. Must have a cut-out (see No. 17 *a*) for each lamp or each series of lamps.

The branch conductors must have a carrying capacity about fifty per cent in excess of the normal current required by the lamp.

b. Must only be furnished with such resistances or regulators as are enclosed in non-combustible material, such resistances being treated as sources of heat. Incandescent lamps must not be used for this purpose.

c. Must be supplied with globes and protected by spark arresters and wire netting around the globe, as in the case of series arc lamps (see No. 19).

29. Arc Lamps on Constant-Potential Circuits—Continued.

Outside arc lamps must be suspended at least eight feet above sidewalks. Inside arc lamps must be placed out of reach or suitably protected.

d. Lamps when arranged to be raised and lowered, either for carboning or other purposes, shall be connected up with stranded conductors from the last point of support to the lamp, when such conductor is larger than No. 14 B. & S. gage.

29 A. Mercury Vapor Lamps.

Enclosed Mercury Vapor Lamps.

a. Must have cut-out for each lamp or series of lamps except when contained in single frame and lighted by a single operation, in which case not more than five lamps should be dependent upon single cut-out.

b. Must only be furnished with such resistances or regulators as are enclosed in non-combustible cases, such resistances to be treated as sources of heat. In locations where these resistances or regulators are subject to flyings of lint or combustible material, all openings through cases must be protected by fine wire gauze.

High Potential Vacuum Tube Systems.

c. The tube must be so installed as to be free from mechanical injury or liability to contact with inflammable material.

d. High potential coils and regulating apparatus must be installed in approved steel cabinet not less than 1-10 inch in thickness; same to be well ventilated in such a manner as to prevent the escape of any flame or sparks, in case of burnout in the various coils. All apparatus in this box must be mounted on slate base and the enclosing case positively grounded. Supplying conductors leading into this high potential case to be installed in accordance with the standard requirements governing low potential systems, where such wires do not carry a potential of over 300 volts.

30. Economy Coils.

a. Economy and compensator coils for arc lamps must be mounted on non-combustible, non-absorptive, insulating supports, such as glass or porcelain, allowing an air space of at least one inch between frame and support, and must in general be treated as sources of heat.

30 A. Transformers.

Oil transformers:—

a. Must not be placed inside of any building except central stations and sub-stations, unless by special permission of the inspection department having jurisdiction.

Air cooled transformers:—

The following sections do not apply to apparatus or fittings, the operation of which depends either wholly or in part upon special transformers embodied in the devices, but all such apparatus or fittings must be submitted for special examination and approval before being used.

b. Must not be placed inside of any building excepting central stations and sub-stations, if the highest voltage of either primary or secondary exceeds 550 volts.

c. Must be so mounted that the case shall be at a distance of at least one foot from combustible material or separated therefrom by non-combustible, non-absorptive, insulating material, such as slate, marble or soapstone. This will require the use of a slab or panel somewhat larger than the transformer.

31. Decorative Lighting Systems.

a. Special permission may be given in writing by the Inspection Department having jurisdiction for the temporary installation of *approved* Systems

31. Decorative Lighting Systems—Continued.

of Decorative Lighting, provided the difference of potential between the wires of any circuit shall not be over 150 volts and also provided that no group of lamps requiring more than 1,320 watts shall be dependent on one cut-out.

31 A. Theatre Wiring.

(*For rules governing Moving Picture Machine, see No. 65 A.*)

All wiring, apparatus, etc., not specifically covered by special rules herein given must conform to the standard Rules and Requirements of the National Electrical Code, and the term "theatre" shall mean a building or part of a building in which it is designed to make a presentation of dramatic, operatic or other performances or shows for the entertainment of spectators which is capable of seating at least four hundred persons, and which has a stage for such performances that can be used for scenery and other stage appliances.

a. Services.

1. Where source of supply is outside of building, there must be at least two separate and distinct services where practicable, fed from separate street mains, one service to be of sufficient capacity to supply current for the entire equipment of theatre, while the other service must be at least of sufficient capacity to supply current for all emergency lights. By "emergency lights" are meant exit lights and all lights in lobbies, stairways, corridors and other portions of theatre to which the public have access which are normally kept lighted during the performance.

This is a matter solely concerning the protection of the person and should therefore be left to the discretion of the assured, so far as the fire risk is concerned.

31 A. Theatre Wiring—Continued.

2. Where source of supply is an isolated plant within same building, an auxiliary service of at least sufficient capacity to supply all emergency lights must be installed from some outside source, or a suitable storage battery within the premises may be considered the equivalent of such service.

This is a matter solely concerning the protection of the person and should therefore be left to the discretion of the assured, so far as the fire risk is concerned.

b. Stage.

1. All permanent construction on stage side of proscenium wall must be *approved* conduit or armored cable, with the exception of border and switchboard wiring.

2. *Switchboards.*—Must be made of non-combustible, non-absorptive material, and where accessible from stage level must be protected by an *approved* guard-rail to prevent accidental contact with live parts on the board.

3. *Footlights:*—

a. Must be wired in *approved* conduit or armored cable, each lamp receptable being enclosed within an *approved* outlet box, the whole to be enclosed in a steel trough, metal to be of a thickness not less than No. 20 gage, or each lamp receptacle may be mounted on or in an iron or steel box so constructed as to enclose all the wires and live parts of receptacles.

b. Must be so wired that no set of lamps requiring more than 1,320 watts will be dependent on one cut-out.

4. *Borders:*—

a. Must be constructed of steel of a thickness not less than No. 20 gage, treated to prevent oxidization, be suitably stayed and

31 A. Theatre Wiring—Continued.

supported by a metal framework, and so designed that flanges of reflectors will protect lamps.

b. Must be so wired that no set of lamps requiring more than 1,320 watts will be dependent upon one cut-out.

c. Must be wired in *approved* conduit or armored cable, each lamp receptacle to be enclosed within an *approved* outlet box, the whole to be enclosed in a steel trough, or each lamp receptacle may be mounted on or in the cover of a steel box so constructed as to enclose all the wires and the live parts of receptacles, metal to be of a thickness not less than No. 20 gage.

d. Must be provided with suitable guards to prevent scenery or other combustible material coming in contact with lamps.

e. Cables must be made up of *approved*, stranded rubber-covered wires; conduit construction must be used from switchboard to point where cables must be flexible to permit of the raising and lowering of border, and flexible portion must be enclosed in an *approved* fireproof hose or braid and be suitably supported.

An approved junction box must be installed at the end of the conduit where the flexible cable leaves for the border.

f. For the wiring of the border proper, wire with *approved* slow burning insulation should be used.

g. Must be suspended with wire rope, same to be insulated from border by at least two *approved* strain insulators properly inserted.

5. *Stage Pockets.*—Must be of approved type controlled from switchboard, each receptacle to

31 A. Theatre Wiring—Continued.

be of not less than fifty ampers rating, and each receptacle to be wired with a separate circuit to its full capacity.

6. *Proscenium Side Lights.*—Must be so installed that they cannot interfere with the operation of or come in contact with curtain.

7. *Scene Docks.*—Where lamps are installed in Scene Docks, they must be so located and installed that they will not be liable to mechanical injury.

8. *Curtain Motors.*—Must be of ironclad type and installed so as to conform to the requirements of the National Electrical Code. (See No. 8.)

9. *Control for Stage Flues:—*

a. In cases where dampers are released by an electric device, the electric circuit operating same must be normally closed.

b. Magnet operating damper must be wound to take full voltage of circuit by which it is supplied, using no resistance device, and must not heat more than normal for apparatus of similar construction. It must be located in loft above scenery, and be installed in a suitable iron box with a tight self-closing door.

c. Such dampers must be controlled by at least two standard single pole switches mounted within *approved* iron boxes provided with self-closing doors without lock or latch, and located, one at the Electrician's station, and others as designated by the Inspection Department having jurisdiction.

c. Dressing Rooms.

1. Must be wired in *approved* conduit or armored cable.

31 A. Theatre Wiring—Continued.

2. All pendent lights must be equipped with approved reinforced cord, armored cable or steel armored flexible cord.

3. All lamps must be provided with *approved* guards.

d. Portable Equipments.

1. *Arc lamps* used for stage effects must conform to the following requirements:—

a. Must be constructed entirely of metal except where the use of *approved* insulating material is necessary.

b. Must be substantially constructed, and so designed as to provide for proper ventilation, and to prevent sparks being emitted from lamps when same is in operation, and mica must be used for frame insulation.

c. Front opening must be provided with a self-closing hinged door frame in which wire gauze or glass must be inserted, excepting lens lamps, where the front may be stationary, and a solid door be provided on back or side.

d. Must be provided with a one-sixteenth-inch iron or steel guard having a mesh not larger than one inch, and be substantially placed over top and upper half of sides and back of lamp frame; this guard to be substantially riveted to frame of lamp, and to be placed at a distance of at least two inches from the lamp frame.

e. Switch on standard must be so constructed that accidental contact with any live portion of same will be impossible.

f. All stranded connections in lamp and at switch and rheostat must be provided with approved lugs,

g. Rheostat, if mounted on standard, must be raised to a height of at least three inches

31 A. Theatre Wiring—Continued.

above floor line, and in addition to being properly enclosed must be surrounded with a substantially attached metal guard having a mesh not larger than one square inch, which guard is to be kept at least one inch from outside frame of rheostat.

h. A competent operator must be in charge of each arc lamp, except that one operator may have charge of two lamps when they are not more than ten feet apart, and are so located that he can properly watch and care for both lamps.

2. *Bunches*:—

a. Must be substantially constructed of metal, and must not contain any exposed wiring.

b. The cable feeding same must be bushed in an approved manner where passing through the metal, and must be properly secured to prevent any mechanical strain from coming on the connection.

3. *Strips*:—

a. Must be constructed of steel of a thickness not less than No. 20 gage, treated to prevent oxidization, and suitably stayed and supported by metal framework.

b. Cable feeding must be bushed in an *approved* manner where passing through the metal, and must be properly secured to prevent any mechanical strain from coming on the connections.

4. *Portable Plugging Boxes.*—Must be constructed so that no current carrying part will be exposed, and each receptacle must be protected by *approved* fuses mounted on slate or marble bases and enclosed in a fireproof cabinet equipped with

31 A. Theatre Wiring—Continued.

self-closing doors. Each receptacle must be constructed to carry thirty amperes without undue heating, and the bus-bars must have a carrying capacity equivalent to the current required for the total number of receptacles, allowing thirty amperes to each receptacle, and *approved* lugs must be provided for the connection of the master cable.

5. *Pin Plug Conductors:*—

a. When of *approved* type may be used to connect *approved* portable lights and appliances.

b. Must be so installed that the "female" part of plug will be on the live end of cable, and must be so constructed that tension on the cable will not cause any serious mechanical strain on the connections.

6. *Lights on Scenery.*—Where brackets are used they must be wired entirely on the inside, fixture stem must come through to the back of the scenery and end of stem be properly bushed.

7. *String or Festooned Lights.*—Wiring for same should be *approved* cable, joints where taps are taken from same for lights to be properly made, soldered and taped, and where lamps are used in lanterns or similar devices lamps must be provided with *approved* guards. Where taps are taken from cable, they should be so staggered that joints of different polarity will not come immediately opposite each other and must be properly protected from strain.

8. *Special Electrical Effects.*—Where devices are used for producing special effects such as lightning, waterfalls, etc., the apparatus must be so constructed and located that flames, sparks, etc., resulting from the operation cannot come in contact with combustible material.

31 A. Theatre Wiring—Continued.

e. Auditorium.

1. All wiring must be installed in *approved* conduit or armored cable.

2. All fuses used in connection with lights illuminating all parts of the house used by the audience must be installed in fireproof enclosures so constructed that there will be a space of at least six inches between the fuses and the sides and face of enclosure.

3. Exit lights must not have more than one set of fuses between same and service fuses.

4. Exit lights and all lights in halls, corridors or any other part of the building used by the audience, except the general auditorium lighting, must be fed independently of the stage lighting, and must be controlled only from the lobby or other convenient place in front of the house.

5. Every portion of the theatre devoted to the use or accommodation of the public, also all outlets leading to the streets and including all open courts, corridors, stairways, exits and emergency exit stairways, should be well and properly lighted during every performance, and the same should remain lighted until the entire audience has left the premises.

31 B. Outline Lighting.

Wiring (Other than Signs on Exterior of Buildings) :—

a. Must be connected only to low-potential systems.

b. Open or conduit work may be used, but molding will not be permitted.

c. For open work, wires must have an approved rubber insulating covering. Must be rigidly supported on non-combustible, non-absorptive insulators, which separate the wires at least one inch from the surface wired over,

31 B. Outline Wiring—Continued.

and must be kept apart at least two and one-half inches for voltages up to 300, and four inches for higher voltages.

Rigid supporting requires, under ordinary conditions where wiring over flat surfaces, supports at least every four and one-half feet. If the wires are liable to be disturbed, the distances between supports should be shortened.

d. Where flexible tubing is required, the ends must be sealed and painted with moisture repellant, and kept at least one-half inch from surface wired over.

e. Wires for use in rigid or flexible steel conduit must comply with requirements for unlined conduit work. Where armored cable is used, the conductors must be protected from moisture by lead sheath between armor and insulation.

f. Must be protected by its own cut-out, and controlled by its own switch. Cut-outs, switches, time switches, flashers and similar appliances, must be of approved design, and must, if located inside the building, be installed as required by the code for such devices. If outside the building they must be enclosed in a steel or cast-iron box.

If a steel box is used, the minimum thickness of the steel must be 0.128 of an inch (No. 8 B. & S. gage).

Boxes must be so constructed that when switch operates the blade shall clear the door by at least one inch, and they must be moisture proof.

h. Circuits must be so arranged that not more than 1,320 watts will be finally dependent upon a single cut-out; nor shall more than 66 sockets or receptacles be connected to single circuit.

31B. Outline Wiring—Continued.

i. Sockets and receptacles must be of the keyless porcelain type, and wires must be soldered to lugs on same.

32. Car Wiring and Equipment of Cars.

a. Protection of Car Body, etc.

1. Under side of car bodies to be protected by *approved* fire-resisting, insulating material, not less than 1-8 inch in thickness, or by sheet iron or steel, not less than .04 inch in thickness, as specified in Section *a*, 2, 3 and 4. This protection to be provided over all electrical apparatus, such as motors with a capacity of over 75 H. P. each, resistances, contactors, lightning arresters, air-brake motors, etc., and also where wires are run, except that protection may be omitted over wires designed to carry 25 amperes or less if they are encased in metal conduit.

2. At motors of over 75 H. P. each, fire-resisting material or sheet iron or steel to extend not less than 8 inches beyond all edges of openings in motors, and not less than six inches beyond motor leads on all sides.

3. Over resistances, contactors, and lightning arresters, and other electrical apparatus, excepting when amply protected by their casing, fire-resisting material or sheet iron or steel to extend not less than 8 inches beyond all edges of the devices.

4. Over conductors, not encased in conduit, and conductors in conduit when designed to carry over 25 amperes, unless the conduit is so supported as to give not less than 1-2 inch clear air space between the conduit and the car, fire-resisting material or sheet iron or steel to extend at least 6 inches beyond conductors on either side.

The fire-resisting insulating material or sheet iron or steel may be omitted over cables made up

32. Car Wiring and Equipment of Cars—Continued.

of flame-proof braided outer covering when surrounded by 1-8 inch flameproof covering, as called for by Section *i*, 4.

5. In all cases fireproof material or sheet iron or steel to have joints well fitted, to be securely fastened to the sills, floor timbers and cross braces, and to have the whole surface treated with a waterproof paint.

6. Cut-out and switch cabinets to be substantially made of hard wood. The entire inside of cabinet to be lined with not less than 1-8 inch fire-resisting insulating material which shall be securely fastened to the woodwork, and after the fire-resisting material is in place the inside of the cabinet shall be treated with a waterproof paint.

b. Wires, Cables, etc.

1. All conductors to be stranded, the allowable carrying capacity being determined by Table "A" of No. 16, except that motor, trolley and resistance leads shall not be less than No. 7 B. & S. gage, heater circuits not less than No. 12 B. & S. gage, and lighting and other auxiliary circuits not less than No. 14 B. & S. gage.

The current used in determining the size of motor, trolley and resistance leads shall be the per cent of the full load current, based on one hour's run of the motor, as given by the following table:—

Size each motor.	Motor Leads.	Trolley Leads.	Resistance Leads.
75 H. P. or less	50%	40%	15%
Over 75 H. P.	45%	35%	15%

Approved fixture wire will be permitted for wiring *approved* clusters.

2. To have an insulation and braid *approved* for wires carrying currents of the same potential.

3. When run in metal conduit, to be protected by an additional braid.

32. Car Wiring and Equipment of Cars—Continued.

Where conductors are laid in conduit, not being drawn through, the additional braid will not be required.

4. When not in conduit, in *approved* moulding, or in cables surrounded by 1-8 inch flame-proof covering, must be *approved* rubber covered (except that tape may be substituted for braid) and be protected by an additional flame-proof braid, at least 1-32 inch in thickness, the outside being saturated with a preservative flame-proof compound. Except that when motors are so enclosed that flame cannot extend outside of the casing, the flame-proof covering will not be required on the motor leads.

5. Must be so spliced or joined as to be both mechanically and electrically secure without solder. The joints must then be soldered and covered with an insulation equal to that on the conductors.

Joints made with *approved* splicing devices and those connecting the leads at motors, plows, or third rail shoes need not be soldered.

6. All connections of cables to cut-outs, switches and fittings, except those to controller connection boards, when designed to carry over 25 amperes, must be provided with lugs or terminals soldered to the cable, and securely fastened to the device, by bolts, screws or by clamping; or, the end of the cable, after the insulation is removed, shall be dipped in solder and be fastened into the device by at least two set screws having check nuts.

All connections for conductors to fittings, etc., designed to carry less than 25 amperes, must be provided with up-turned lugs that will grip the conductor between the screw and the lug, the screws being provided with flat washers; or by block terminals having two set screws, and the end of the conductors must be dipped in solder.

32. Car Wiring and Equipment of Cars—Continued.

Soldering, in addition to the connection of the binding screws, is strongly recommended, and will be insisted on when above requirements are not complied with.

This rule only to apply to circuits where the maximum potential is over 25 volts and current exceeds 5 amperes.

c. Cut-outs, Circuit Breakers and Switches.

1. All cut-outs and switches having exposed live metal parts to be located in cabinets. Cut-outs and switches, not in iron boxes or in cabinets, shall be mounted on not less than 1-4 inch fire-resisting insulating material, which shall project at least 1-2 inch beyond all sides of the cut-out or switch.

2. Cut-outs to be of the *approved* cartridge or *approved* blow out type.

3. All switches controlling circuits of over 5 ampere capacity shall be of *approved* single pole, quick break or *approved* magnetic blow-out type.

Switches controlling circuits of 5 ampere or less capacity may be of the *approved* single pole, double break, snap type.

4. Circuit breakers to be of *approved* type.

5. Circuits must not be fused above their safe carrying capacity.

6. A cut-out must be placed as near as possible to the current collector, so that the opening of the fuse in this cut-out will cut off all current from the car.

When cars are operated by metallic return circuits, with circuit breakers connected to both sides of the circuit, no fuses in addition to the circuit breakers will be required.

32. Car Wiring and Equipment of Cars—Continued.

d. Conduit.

When from the nature of the case, or on account of the size of the conductors, the ordinary pipe and junction box construction is not permissible, a special form of conduit system may be used, provided the general requirements as given below are complied with.

1. Metal conduits, outlet and junction boxes to be constructed in accordance with standard requirements except that conduit for lighting circuits need not be over 5-16 inch internal diameter and 1-2 inch external diameter, and for heating and air motor circuits need not be over 3-8 inch internal diameter and 9-16 inch external diameter, and all conduits where exposed to dampness must be water tight.

2. Must be continuous between and be firmly secured into all outlet or junction boxes and fittings, making a thorough mechanical and electrical connection between same.

3. Metal conduits, where they enter all outlet or junction boxes and fittings, must be provided with *approved* bushings fitted so as to protect cables from abrasion.

4. Except as noted in Section *i*, 2, must have the metal of the conduit permanently and effectively grounded.

5. Junction and outlet boxes must be installed in such a manner as to be accessible.

6. All conduits, outlets or junction boxes and fittings to be firmly and substantially fastened to the framework of the car.

e. Moulding.

1. To consist of a backing and a capping and to be constructed of fire-resisting insulating material, except that it may be made of hard wood where the circuits which it is designed to support are normally not exposed to moisture.

2. When constructed of fire-resisting insulating material, the backing shall be not less than 1-4

32. Car Wiring and Equipment of Cars—Continued.

inch in thickness and be of a width sufficient to extend not less than 1 inch beyond conductors at sides.

The capping, to be not less than 1-8 inch in thickness shall cover and extend at least 3-4 inch beyond conductors on either side.

The joints in the moulding shall be mitred to fit close, the whole material being firmly secured in place by screws or nails, and treated on the inside and outside with a waterproof paint.

When fire-resisting moulding is used over surfaces already protected by 1-8 inch fire-resisting insulating material no backing will be required.

3. Wooden mouldings must be so constructed as to thoroughly encase the wire and provide a thickness of not less than 3-8 inch at the sides and back of the conductors, the capping being not less than 3-16 inch in thickness. Must have both outside and inside two coats of waterproof paint.

The backing and the capping shall be secured in place by screws.

f. Lighting and Lighting Circuits.

1. Each outlet to be provided with an *approved* receptacle, or an *approved* cluster. No lamp consuming more than 128 watts to be used.

2. Circuits to be run in *approved* metal conduit, or *approved* moulding.

3. When metal conduit is used, except for sign lights, all outlets to be provided with *approved* outlet boxes.

4. At outlet boxes, except where *approved* clusters are used, receptacles to be fastened to the inside of the box, and the metal cover to have an insulating bushing around opening for the lamp.

When *approved* clusters are used, the cluster shall be thoroughly insulated from the metal con-

32. Car Wiring and Equipment of Cars—Continued.

duit, being mounted on a block of hard wood or fire-resisting insulating material.

5. Where conductors are run in moulding the receptacles or cluster to be mounted on blocks of hard wood or of fireproof insulating material.

g. Heaters and Heating Circuits.

1. Heaters to be of *approved* type.

2. Panel heaters to be so constructed and located that when heaters are in place all current carrying parts will be at least 4 inches from all woodwork.

Heaters for cross seats to be so located that current carrying parts will be at least 6 inches below under side of seat, unless under side of seat is protected by not less than 1-4 inch fire-resisting insulating material, or .04 inch sheet metal with 1 inch air space over same, when the distance may be reduced to 3 inches.

Truss plank heaters to be mounted on not less than one-quarter inch fire-resisting insulating material, the legs or supports for the heaters providing an air space of not less than one-half inch between the back of the heater and the insulating material.

3. Circuits to be run in *approved* metal conduit, or in *approved* moulding, or if the location of conductors is such as will permit an air space of not less than 2 inches on all sides except from the surface wired over, they may be supported on porcelain knobs or cleats, provided the knobs or cleats are mounted on not less than 1-4 inch fire-resisting insulating material extending at least 3 inches beyond conductors at either side, the supports raising the conductors not less than 1-2 inch from the surface wired over, and being not over 12 inches apart.

h. Air Pump Motor and Circuits.

1. Circuits to be run in *approved* metal conduit or in *approved* moulding, except that when

32. Car Wiring and Equipment of Cars—Continued.

run below the floor of the car they may be supported on porcelain knobs or cleats, provided the supports raise the conductor at least 1-2 inch from the surface wired over and are not over 12 inches apart.

2. Automatic control to be enclosed in *approved* metal box. Air pump and motor, when enclosed, to be in *approved* metal box or a wooden box lined with metal of not less than 1-32 inch in thickness.

When conductors are run in metal conduit the boxes surrounding automatic control and air pump and motor may serve as outlet boxes.

i. Main Motor Circuits and Devices.

1. Conductors connecting between trolley stand and main cut-out or circuit breakers in hood to be protected where wires enter car to prevent ingress of moisture.

2. Conductors connecting between third rail shoes on same truck, to be supported in an *approved* fire-resisting insulating moulding, or in *approved* iron conduit supported by soft rubber or other *approved* insulating cleats.

3. Conductors on the under side of the car, except as noted in Section *i*, 4, to be supported in accordance with one of the following methods:—

a. To be run in *approved* metal conduit, junction boxes being provided where branches in conduit are made, and outlet boxes where conductors leave conduit.

b. To be run in *approved* fire-resisting insulating moulding.

c. To be supported by insulating cleats, the supports being not over 12 inches apart.

4. Conductors with flameproof braided outer covering, connecting between controllers at either

32. Car Wiring and Equipment of Cars—Continued.

end of car, or controllers and contactors, may be run as a cable, provided the cable where exposed to the weather is encased in a canvas hose or canvas tape, thoroughly taped or sewed at ends and where taps from the cable are made, and the hose or tape enters the controllers.

Conductors with or without flameproof braided outer covering connecting between controllers at either end of the car, or controllers and contactors, may be run as a cable, provided the cable throughout its entire length is surrounded by 1-8 inch flameproof covering, thoroughly taped or sewed at ends, or where taps from cable are made, and the flameproof covering enters the controllers.

Cables where run below floor of car may be supported by *approved* insulating straps or cleats. Where run above floor of car, to be in a metal conduit or wooden box painted on the inside with not less than two coats of flameproof paint, and where this box is so placed that it is exposed to water, as by washing of the car floor, attention should be given to making the box reasonably waterproof.

Canvas hose or tape, or flameproof material surrounding cables after conductors are in same, to have not less than two coats of waterproof insulating material.

5. Motors to be so drilled that, on double truck cars, connecting cables can leave motor on side nearest to king bolt.

6. Resistances to be so located that there will be at least 6 inch air space between resistances proper and fire-resisting material of the car. To be mounted on iron supports, being insulated by non-combustible bushings or washers, or the iron supports shall have at least 2 inches of insulating surface between them and metal work of car, or the resistances may be mounted on hard wood bars, supported by iron stirrups, which shall have not less than 2 inches of insulating surface be-

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32. Car Wiring and Equipment of Cars—Continued.

tween foot of resistance and metal stirrup, the entire surface of the bar being covered with at least 1-8 inch fire-resisting insulating material.

The insulation of the conductor, for about 6 inches from terminal of the resistance, should be replaced, if any insulation is necessary, by a porcelain bushing or asbestos sleeve.

7. Controllers to be raised above platform of car by a not less than 1 inch hard wood block, the block being fitted and painted to prevent moisture working in between it and the platform.

j. Lightning Arresters.

1. To be preferably located to protect all auxiliary circuits in addition to main motor circuits.

2. The ground conductor shall be not less than No. 6 B. & S. gage, run with as few kinks and bends as possible, and be securely grounded.

k. General Rules.

1. When passing through floors, conductors or cables must be protected by *approved* insulating bushings, which shall fit the conductor or cable as closely as possible.

2. Moulding should never be concealed except where readily accessible. Conductors should never be tacked into moulding.

3. Short bends in conductors should be avoided where possible.

4. Sharp edges in conduit or in moulding must be smoothed to prevent injury to conductors.

33. Car Houses.

a. The trolley wires must be securely supported on insulating hangers.

b. The trolley hangers must be placed at such a distance apart that, in case of a break in the

33. Car Houses—Continued.

trolley wire, contact with the floor cannot be made.

c. Must have an emergency cut-out switch located at a proper place outside of the building, so that all the trolley wires in the building may be cut out at one point, and line insulators must be installed, so that when this emergency switch is open, the trolley wire will be dead at all points within 100 feet of the building. The current must be cut out of the building when not needed for use in the building.

This may be done by the emergency switch, or if preferred a second switch may be used that will cut out all current from the building, but which need not cut out the trolley wire outside as would be the case with the emergency switch.

d. All lamps and stationary motors must be installed in such a way that one main switch may control the whole of each installation, lighting and power, independently of the main cut-out switch called for in Section *c*.

e. Where current for lighting and stationary motors is from a grounded trolley circuit, the following special rules to apply:—

1. Cut-outs must be placed between the non-grounded side and lights or motors they are to protect. No set or group of incandescent lamps requiring over 2,000 watts must be dependent upon one cut-out.
2. Switches must be placed between non-grounded side and lights and motors they are to protect.
3. Must have all rails bonded at each joint with a conductor having a carrying capacity at least equivalent to No. 0 B. & S. gage annealed copper wire, and all rails must be connected to the outside ground return circuit by a not less than No. 0 B. & S. gage copper wire or by

33. Car Houses—Continued.

equivalent bonding through the track. All lighting and stationary motor circuits must be thoroughly and permanently connected to the rails or to the wire leading to the outside ground return circuit.

f. All pendant cords and portable conductors will be considered as subject to hard usage.

g. Must, except as provided in Section *e*, have all wiring and apparatus installed in accordance with the rules for constant potential systems.

h. Must not have any system of feeder distribution centering in the building.

i. Cars must not be left with the trolley in electrical connection with the trolley wire.

34, Lighting and Power from Railway Wires.

a. Must not be permitted, under any pretence, in the same circuit with trolley wires with a ground return, except in electric railway cars, electric car houses, power houses, passenger and freight stations connected with the operation of electric railways.

34 A. Electric Cranes.

All wiring, apparatus, etc., not specifically covered by special rules herein given, must conform to the Standard Rules and Requirements of the National Electrical Code, except that the switch required by Rule 8c for each motor may be omitted.

a. Wiring.

1. All wires except bare collector wires, those between resistances and contact plates of rheostats and those subjected to severe external heat, must

34 A. Electric Cranes—Continued.

be approved, rubber-covered and not smaller in size than No. 12 B. & S. Insulation on wires between resistances and contact plates of rheostats must conform to Section *d*, while wires subjected to severe external heat must have approved slow-burning insulation.

2. All wires excepting collector wires and those run in metal conduit or approved flexible cable must be supported by knobs or cleats which separate them at least one inch from the surface wired over, but in dry places where space is limited the distance between wires as required by Rule 24-*h* cannot be obtained, each wire must be separately encased in approved flexible tubing securely fastened in place.

Collector wires must be supported by approved insulators so mounted that even with the extreme movement permitted the wires will be separated at all times at least 1 1-2 inches from the surface wired over. Collector wires must be held at the ends by approved strain insulators.

3. Main collector wires carried along the runways must be rigidly and securely attached to their insulating supports at least every 20 feet, and separated at least six inches when run in a horizontal plane; if not run in a horizontal plane, they must be separated at least 8 inches. If spans longer than 20 feet are necessary the distance between wires must be increased proportionately but in no case shall the span exceed 40 feet.

4. Where bridge collector wires are over 80 feet long, insulating supports on which the wires may loosely lie must be provided at least every 50 feet.

Bridge collector wires must be kept at least 2 1-2 inches apart, but a greater spacing should be used whenever it may be obtained.

34 A. Electric Cranes—Continued.

5. Collector wires must not be smaller in size than specified in the following table for the various spans.

Distance between rigid supports. Feet.	Size wire required. B. & S.
0 to 30	6
31 to 60	4
Over 60	2

b. Collectors.

Must be so designed that sparking between them and collector wires will be reduced to a minimum.

c. Switches and Cut-outs.

1. The main collector wires must be protected by a cut-out and the circuit controlled by a switch. Cut-out and switch to be so located as to be easy of access from the floor.

2. Cranes operated from cabs must have a cut-out and switch connected into the leads from the main collector wires and so located in the cab as to be readily accessible to the operator.

3. Where there is more than one motor on a single crane, each motor lead must be protected by a cut-out located in the cab if there is one.

d. Controllers.

Must be installed according to No. 4, except that if the crane is located out doors the insulation on wires between resistances and contact plates of rheostats must be rubber where the wires are exposed to moisture and insulation is necessary and also where they are grouped. If the crane operates over readily combustible material, the resistances must be placed in an enclosure made of non-combustible material, thoroughly

34 A. Electric Cranes—Continued.

ventilated and so constructed that it will not permit any flame or molten metal to escape in the event of burning out the resistances. If the resistances are located in the cab, this result may be obtained by constructing the cab of non-combustible material and providing sides which enclose the cab from its floor to a height at least 6 inches above the top of the resistances.

e. Grounding of Iron Work.

The motor frames, the entire frame of the crane and the tracks must be permanently and effectively grounded.

HIGH-POTENTIAL SYSTEMS.

550 TO 3,500 VOLTS.

Any circuit attached to any machine or combination of machines which develops a difference of potential between any two wires, of over 550 volts and less than 3,500 volts, shall be considered at a high-potential circuit, and as coming under that class, unless an approved transforming device is used, which cuts the difference of potential down to 550 volts or less. For 550 volt motor equipments a margin of ten per cent above the 550 volt limit will be allowed at the generator or transformer without coming under high-potential systems.

35. Wires.

(*See also Nos. 14, 15 and 16.*)

a. Must have an *approved* rubber-insulating covering.

b. Must be always in plain sight and never encased, except as provided for in No. 8 *b*, or where required by the Inspection Department having jurisdiction.

c. Must (except as provided for in No. 8 *b*), be rigidly supported on glass or porcelain insulators, which raise the wire at least one inch from the surface wired over, and must be kept about eight inches apart.

Rigid supporting requires under ordinary conditions, where wiring along flat surfaces, supports at least about every four and one-half feet. If the wires are unusually liable to be disturbed, the distance between supports must be shortened.

In buildings of mill construction, mains of not less than No. 8 B. & S. gage, where not liable to be disturbed, may be separated about ten inches and run from timber to timber, not breaking around, and may be supported at each timber only.

35. Wires—Continued.

d. Must be protected on side walls from mechanical injury by a substantial boxing, retaining an air space of one inch around the conductors, closed at the top (the wires passing through bushed holes) and extending not less than seven feet from the floor. When crossing floor timbers, in cellars, or in rooms where they might be exposed to injury, wires must be attached by their insulating supports to the under side of a wooden strip not less than one half an inch in thickness.

36. Transformers. (When permitted inside buildings under No. 13.)

(*See also Nos. 13 and 13 A.*)

Transformers must not be placed inside of buildings without special permission from the Inspection Department having jurisdiction.

a. Must be located as near as possible to the point at which the primary wires enter the building.

b. Must be placed in an enclosure constructed of fire-resisting material; the enclosure to be used only for this purpose, and to be kept securely locked, and access to the same allowed only to responsible parties.

c. Must be thoroughly insulated from the ground, or permanently and effectually grounded, and the enclosure in which they are placed must be practically air-tight, except that it must be thoroughly ventilated to the outdoor air, if possible through a chimney or flue. There should be at least six inches air space on all sides of the transformer.

37. Series Lamps.

a. No multiple series or series multiple system of lighting will be approved.

b. Must not, under any circumstances, be attached to gas fixtures.

EXTRA-HIGH-POTENTIAL SYSTEMS.

OVER 3,500 VOLTS.

Any circuit attached to any machine or combination of machines which develops a difference of potential, between any two wires, of over 3,500 volts, shall be considered as an extra-high-potential circuit, and as coming under that class, unless an approved transforming device is used, which cuts the difference of potential down to 3,500 volts or less.

38. Primary Wires.

a. Must not be brought into or over buildings, except power stations and sub-stations.

39. Secondary Wires.

a. Must be installed under rules for high-potential systems when their immediate primary wires carry a current at a potential of over 3,500 volts, unless the primary wires are installed in accordance with the requirements as given in No. 12 A or are entirely underground, within city, town and village limits.

CLASS D

containing rules No. 40 to 63 inclusive relating to Construction of Fittings and Materials is omitted from this pamphlet.

CLASS E.

MISCELLANEOUS.

64. Signaling Systems.

Governing wiring for telephone, telegraph, district messenger and call-bell circuits, fire and burglar alarms, and all similar systems which are hazardous only because of their liability to become crossed with electric light, heat or power circuits.

a. Outside wires should be run in underground ducts or strung on poles, and kept off of the roofs of buildings, except by special permission of the Inspection Department having jurisdiction, and must not be placed on the same cross-arm with electric light or power wires. They should not occupy the same duct, manhole or handhole of conduit systems with electric light or power wires.

Single manholes, or handholes separated into sections by means of partitions of brick or tile will be considered as conforming with the above rule.

The liability of accidental crossing of overhead signaling circuits with electric light and power circuits may be guarded against to a considerable extent by endeavoring to keep the two classes of circuits on different sides of the same street.

When the entire circuit from Central Station to building is run in underground conduits, Sections *b* to *m* inclusive do not apply.

b. When outside wires are run on same pole with electric light or power wires, the distance between the two inside pins of each cross-arm must not be less than twenty-four inches.

Signaling wires being smaller and more liable to break and fall, should generally be placed on the lower cross-arms.

64. Signaling Systems—Continued.

When the wires are carried in approved cables, the next three sections (*c, d and e*) *do not apply.*

c. Where wires are attached to the outside walls of buildings, they must have an *approved* rubber insulating covering, and on frame buildings or frame portions of other buildings shall be supported on glass or porcelain insulators, or knobs.

d. The wires from last outside support to the cut-outs or protectors must be of copper, and must have an *approved* rubber insulation must be provided with drip loops immediately outside the building and at entrance; must be kept not less than two and one-half inches apart.

e. Wires must enter building through approved non-combustible, non-absorptive, insulating bushings sloping upward from the outside.

Installations where the Current Carrying Parts of the Apparatus Installed are Capable of Carrying Indefinitely a Current of Ten Amperes.

f. An all-metallic circuit shall be provided, except in telegraph systems.

g. At the entrance of wires to building, *approved* single pole cut-outs, designed for 251-600 volts potential and containing fuses rated at not over ten amperes capacity, shall be provided for each wire. These cut-outs must not be placed in the immediate vicinity of easily ignitible stuff, or where exposed to inflammable gases, or dust or to flyings of combustible material.

h. The wires inside building shall be of copper not less than No. 16 B. & S. gage, and must have insulation and be supported, the same as would be required for an installation of electric light or power wiring, 0-600 volts potential.

i. The instruments shall be mounted on bases constructed of non-combustible, non-absorptive,

64. Signaling Systems—Continued.

insulating material. Holes for the supporting screws must be so located, or countersunk, that there will be at least one-half inch space, measured over the surface, between the head of the screw and the nearest live metal part.

Installations where the Current Carrying Parts of the Apparatus Installed are Not Capable of Carrying Indefinitely a Current of Ten Amperes.

j. Must be provided with an *approved* protective device located as near as possible to the entrance of wires to building. The protector must not be placed in the immediate vicinity of easily ignitible stuff, or where exposed to inflammable gases or dust or flyings of combustible materials.

k. Wires from entrance to building to protector must be supported on porcelain insulators, so that they will come in contact with nothing except their designed supports.

l. The ground wire of the protective device shall be run in accordance with the following requirements:—

1. Shall be of copper and not smaller than No. 18 B. & S. gage.
2. Must have an insulating covering *approved* for voltages from 0 to 600, except that the preservative compound may be omitted.
3. Must run in as straight a line as possible to a good permanent ground. This may be obtained by connecting to a water or gas pipe connected to the street mains or to a ground rod or pipe driven in permanently damp earth. When connections are made to pipes, preference shall be given to water pipes. If attachment is made to

64. Signaling Systems—Continued.

gas pipe, the connection in all cases must be made between the meter and the street mains. In every case the connection shall be made as near as possible to the earth.

When the ground wire is attached to a water pipe or a gas pipe, it may be connected by means of an approved ground clamp fastened to a thoroughly clean portion of said pipe, or the pipe shall be thoroughly cleaned and tinned with rosin flux solder, and the ground wire shall then be wrapped tightly around the pipe and thoroughly soldered to it.

When the ground wire is attached to a ground rod driven into the earth, the ground wire shall be soldered to the rod in a similar manner.

Steam or hot-water pipes must not be used for a protector ground.

m. The protector to be approved must comply with the following requirements:—

For Instrument Circuits of Telegraph Systems.

1. An *approved* single pole cut-out, in each wire, designed for 2,000 volts potential, and containing fuses rated at not over one ampere capacity. When main line cut-outs are installed as called for in section *g*, the instrument cut-outs may be placed between the switchboard and the instrument as near the switchboard as possible.

For All Other Systems.

1. Must be mounted on non-combustible, non-absorptive, insulating bases, so designed that when the protector is in place, all parts which may be alive will be thoroughly insulated from the wall to which the protector is attached.

64. Signaling Systems—Continued.

2. Must have the following parts:—

A lightning arrester which will operate with a difference of potential between wires of not over 500 volts, and so arranged that the chance of accidental grounding is reduced to a minimum.

A fuse designed to open the circuit in case the wires become crossed with light or power circuits. The fuse must be able to open the circuit without arcing or serious flashing when crossed with any ordinary commercial light or power circuit.

A heat coil, if the sensitiveness of the instrument demands it, which will operate before a sneak current can damage the instrument the protector is guarding.

Heat coils are necessary in all circuits normally closed through magnet windings, which cannot indefinitely carry a current of at least five amperes.

The heat coil is designed to warm up and melt out with a current large enough to endanger the instruments if continued for a long time, but so small that it would not blow the fuses ordinarily found necessary for such instruments. The smaller currents are often called "sneak" currents.

3. The fuses must be so placed as to protect the arrester and heat coils, and the protector terminals must be plainly marked "line," "instrument," "ground."

An easily read abbreviation of the above words will be allowed.

64. Signaling Systems—Continued.

The Following Rules Apply to All Systems whether the Wires from the Central Office to the Building are Overhead or Underground.

n. Wires beyond the protector, or wires inside buildings where no protector is used, must be neatly arranged and securely fastened in place in some convenient, workmanlike manner.

They must not come nearer than three inches to any electric light or power wire in the building, unless separated therefrom by some continuous and firmly fixed non-conductor creating a permanent separation; this non-conductor to be in addition to the regular insulation on the wire.

The wires would ordinarily be insulated, but the kind of insulation is not specified, as the protector is relied upon to stop all dangerous currents. Porcelain tubing or *approved* flexible tubing may be used for encasing wires where required as above.

o. Wires where bunched together in a vertical run within any building must have a fire-resisting covering sufficient to prevent the wires from carrying fire from floor to floor unless they are run either in non-combustible tubing or in a fireproof shaft, which shaft must be provided with fire stops at each floor.

Signaling wires and electric light or power wires may be run in the same shaft, provided that one of these classes of wires is run in non-combustible tubing, or provided that when run otherwise these two classes of wires shall be separated from each other by at least two inches.

In no case shall signaling wires be run in the same tube with electric light or power wires.

65. Electric Gas Lighting.

a. Electric gas lighting, unless it is the *frictional* system, must not be used on the same fixture with the electric light.

65 A. Moving Picture Machines.

a. Arc lamp used as a part of moving picture machines must be constructed similar to arc lamps of theatres, and wiring of same must not be of less capacity than No. 6 B. & S. gage. (See No. 31A *d.* [1].)

b. Rheostats must conform to rheostat requirements for theatre arcs. (See No. 31A *d.* [1].)

c. Top reel must be encased in a steel box with hole at the bottom only large enough for film to pass through, and cover so arranged that this hole can be instantly closed. No solder to be used in the construction of this box.

d. A steel box must be used, for receiving the film after being shown, with a hole in the top only large enough for the film to pass through freely, with a cover so arranged that this hole can be instantly closed. An opening may be placed at the side of the box to take the film out, with a door hung at the top, so arranged that it cannot be entirely opened, and provided with spring catch to lock it closed. No solder to be used in the construction of this box.

e. The handle or crank used in operating the machine must be secured to the spindle or shaft, so that there will be no liability of its coming off and allowing the film to stop in front of lamp.

f. A shutter must be placed in front of the condenser, arranged so as to be readily closed.

g. Extra films must be kept in metal box with tight fitting cover.

h. Machines must be operated by hand (motor driven will not be permitted).

i. Picture machine must be placed in an enclosure or house made of suitable fireproof material, be thoroughly ventilated and large enough for operator to walk freely on either side of or back of machine. All openings into this booth must be arranged so as to be entirely closed by

65 A. Moving Picture Machines—Continued.

doors or shutters constructed of the same or equally good fire-resisting material as the booth itself. Doors or covers must be arranged so as to be held normally closed by spring hinges or equivalent devices.

66. Insulation Resistance.

The wiring in any building must test free from grounds; *i. e.*, the complete installation must have an insulation between conductors and between all conductors and the ground (not including attachments, sockets, receptacles, etc.) not less than that given in the following table:—

Up to	5	amperes	4,000,000	ohms.
"	10	"	2,000,000	"
"	25	"	800,000	"
"	50	"	400,000	"
"	100	"	200,000	"
"	200	"	100,000	"
"	400	"	50,000	"
"	800	"	25,000	"
"	1,600	"	12,500	"

The test must be made with all cut-outs and safety devices in place. If the lamp sockets, receptacles, electroliers, etc., are also connected, only one half of the resistances specified in the table will be required.

67. Soldering Fluid.

a. The following formula for soldering fluid is suggested:—

Saturated solution of zinc chloride.....5 parts
Alcohol .....4 parts
Glycerine.....1 part

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